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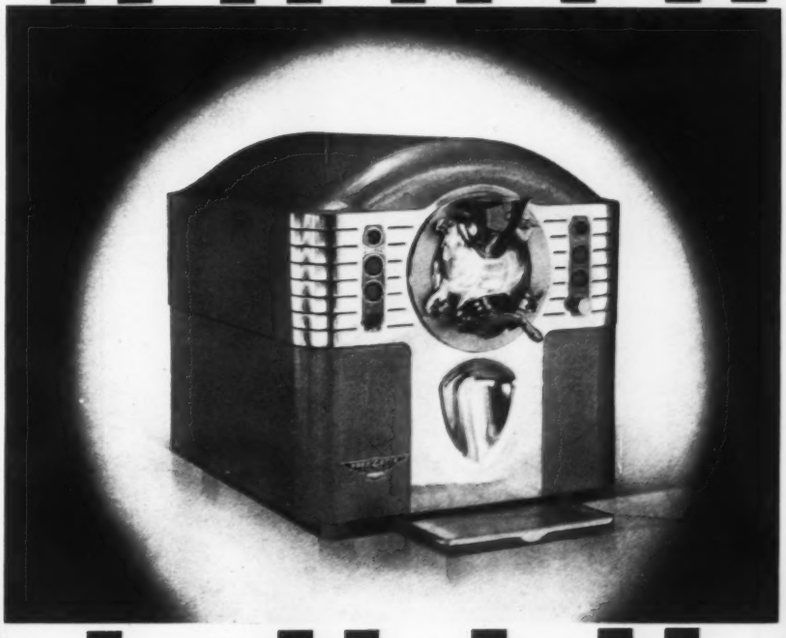
MACHINE DESIGN



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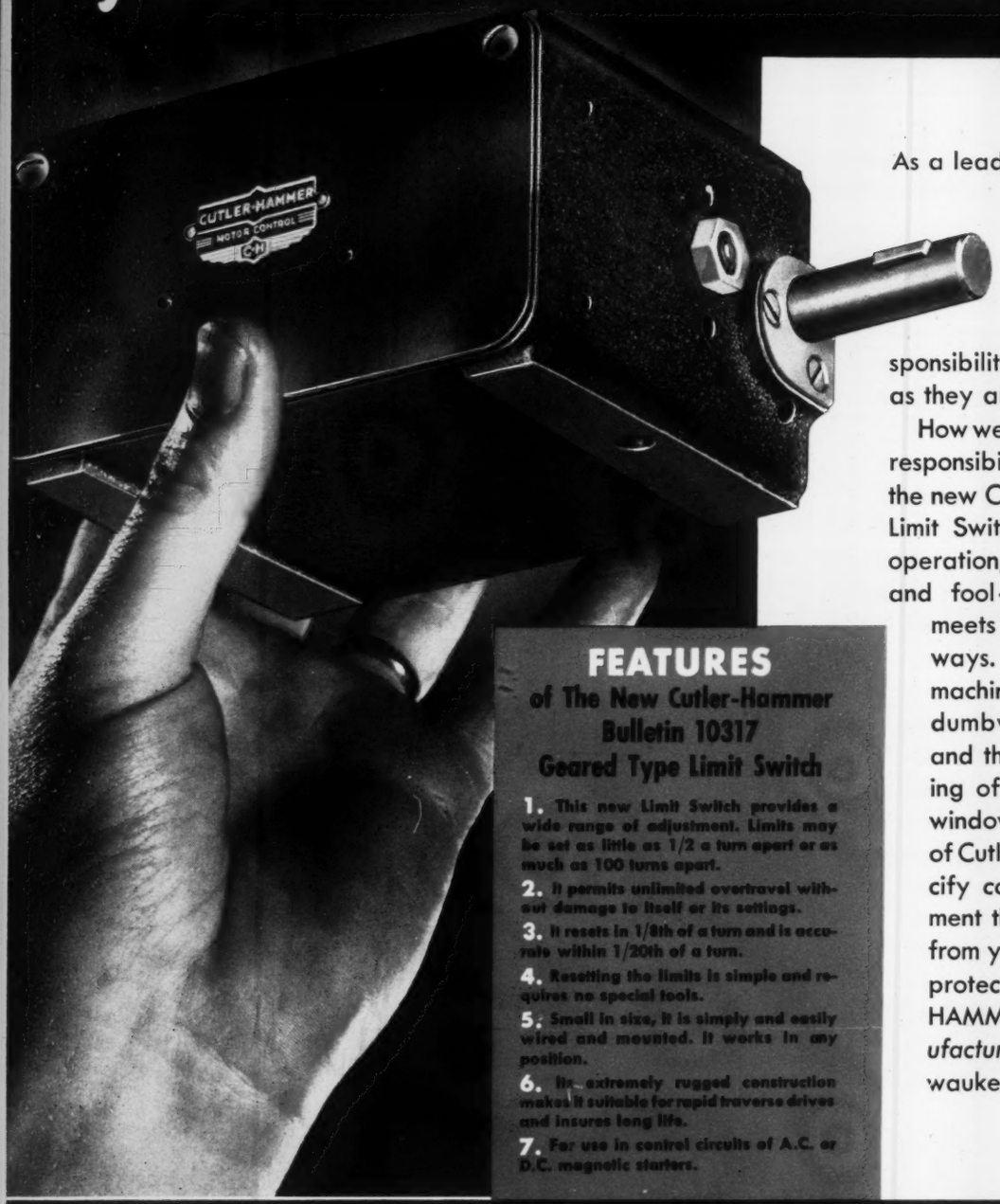

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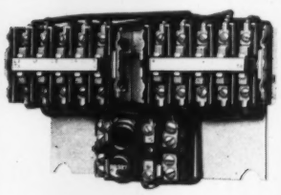

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MACHINE DESIGN

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

Volume 12 — JUNE 1940 — Number 6

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THE FORGED STEEL BEARING

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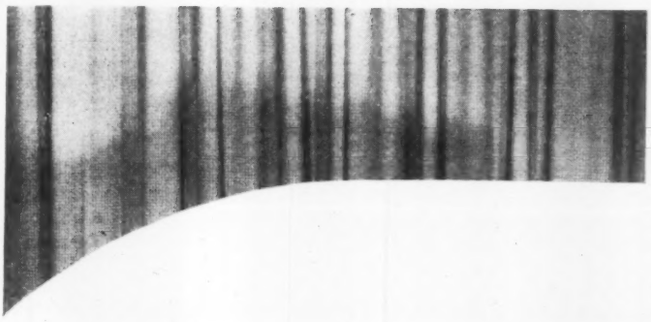
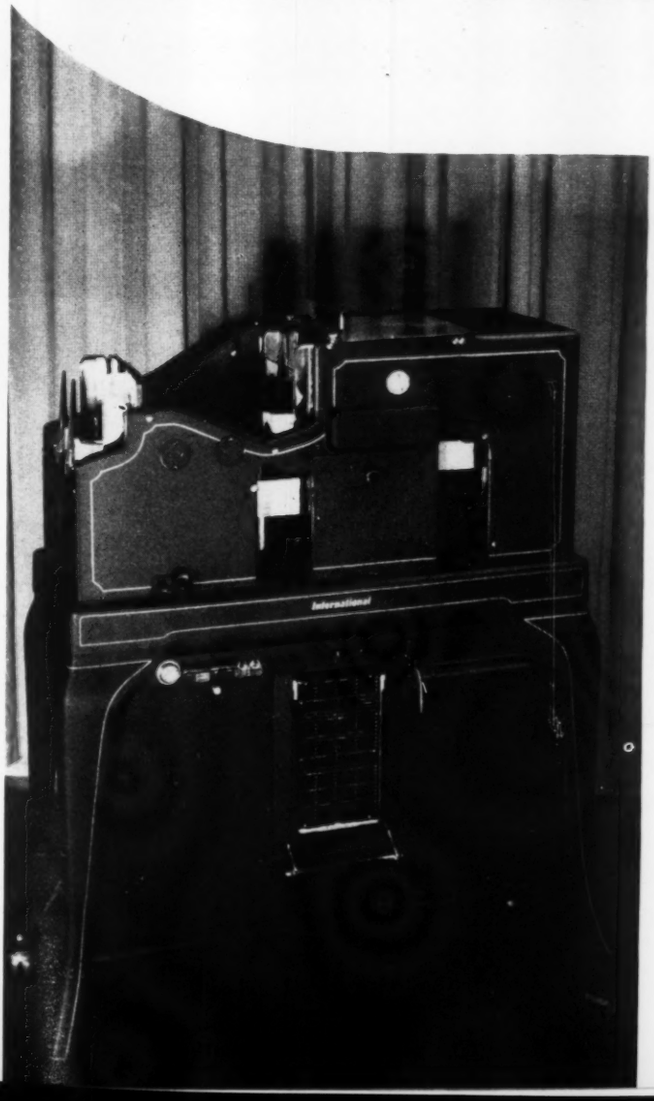
MACHINE DESIGN



Continuous Development Perfects Business Machine

By F. E. Hamilton
International Business Machines Corp.



DESIGN is never static. Continuous changes during the design and development of a machine are absolutely essential if that machine is to command a commercially satisfactory market. A good example is the machine shown in *Fig.* 1, an International electric card reproducing punch. Capable of reproducing all or any part of the punched hole information from one group of master cards to another group, the machine automatically compares the duplicate with master card. Features are incorporated to provide fast accurate operation with adequate protection of the machine details.

Two main units, the feed unit and punching unit comprise the machine. The principle of operation is to read the holes punched in master cards and simultaneously to energize electromagnets in differential time relation to the position of the card to be punched. These electromagnets cause inter-

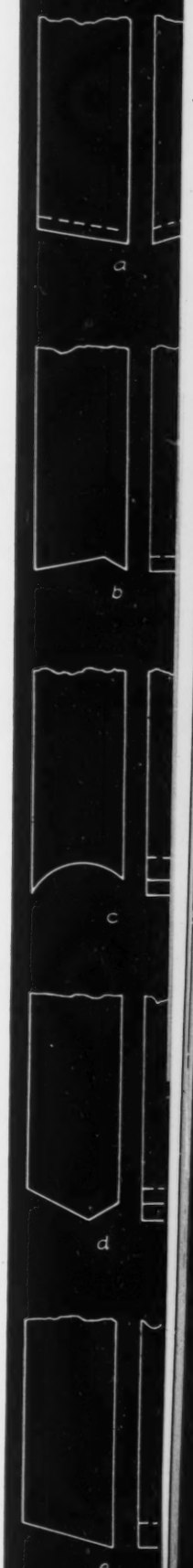


Fig. 1—Left—Machine reproduces punched hole information on duplicate cards. Fig. 2—Right—Various punches developed during search for best design

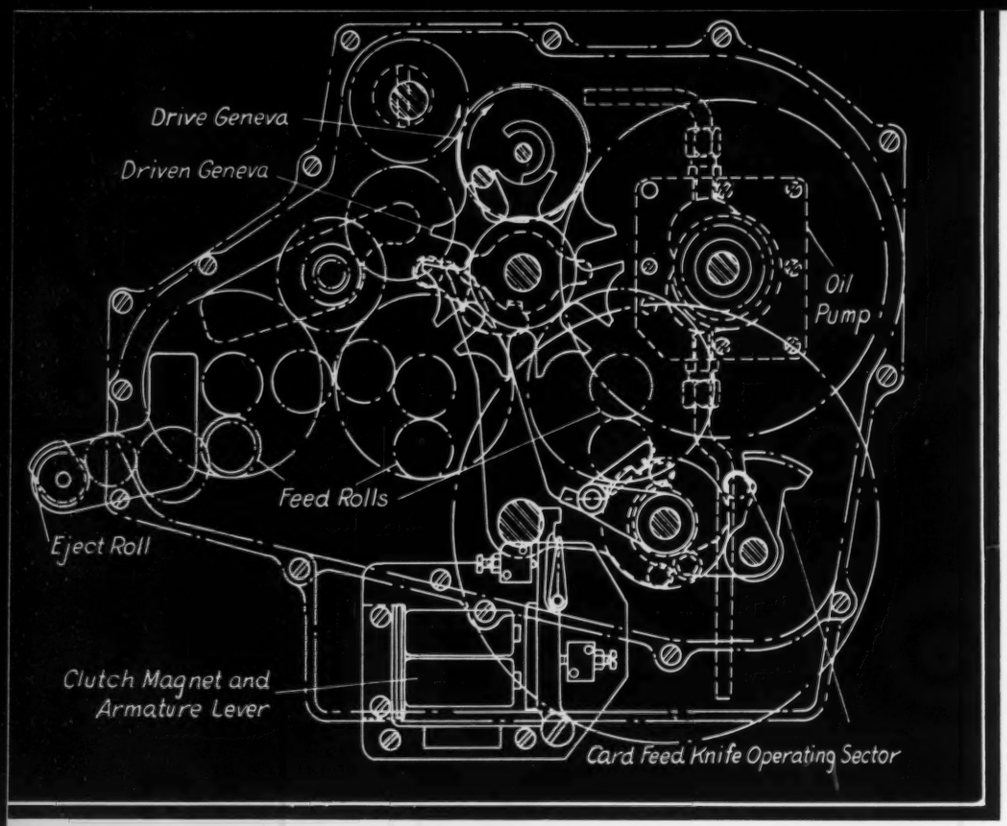


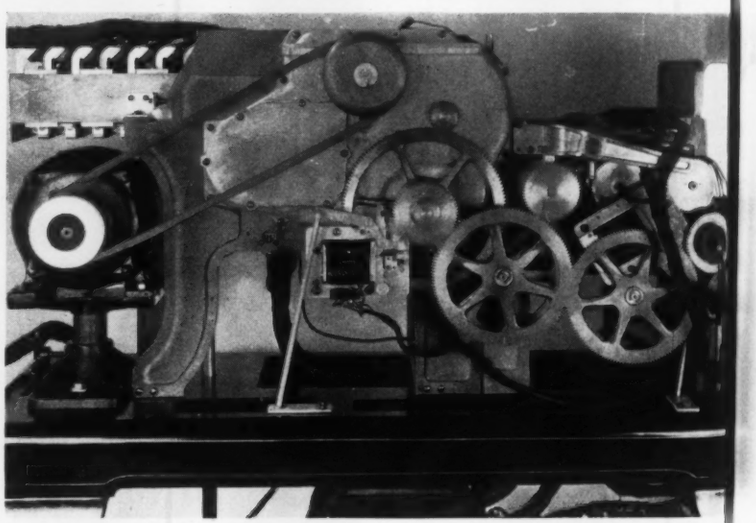
Fig. 3—Geneva mechanism places cards quickly in position with desirable acceleration and deceleration action. Oil pump provides positive lubrication and reduces sealing problems on shafts

Fig. 4—Removed cover discloses motor mounting and drive arrangement. Gear train drives feed rolls for handling cards through machine

posers to be moved into the path of a punch bail which forces the punch through the card. Instead of using the conventional spring-returned punch, this machine provides for the punch being positively withdrawn by the action of the punch bail in the notch of the punch interposer.

Development of the machine brought out many interesting conditions concerning the shape of the punch end. As the machine must be capable of punching 80 holes at one time, it was found that punches with a flat end required too much power to force them through the paper. Also, the noise caused by all these punches breaking through a card at one time was objectionable. It was desirable that the power required for punching the hole be distributed over the whole operation rather than at one time. This suggested a shearing action between the punch and die. Several designs were made of punches with the end ground to give a shearing action, as shown in *Fig.* 2. The one that satisfied all of the requirements for a shear is shown in *Fig.* 2*a* in which the end is ground so that both the long and short sides of the punch form an angle to the plane of the card. This causes the first contact of the punch with the card to be a point instead of a line.

Although having the easiest punching action, this punch had a tendency to pull the slug back through the hole because of the extreme lightness of the paper slug. Possible presence of oil on the end of the punch, static and also the fact that the slug lay at two angles with the plane of the card on the end of the punch handicapped the die or the hole in the card in stripping the slug off the punch. Of the many incredible conditions that occurred because of this tendency to pull slugs, there are probably two that are outstanding: One was to have the slug partially pulled through the hole, and the subsequent movement of the card caused the slug to be folded around the edge of the hole. The other was an instance of the slug being completely drawn through the hole, turned over, and replaced in the same hole from which it had been punched.



Each of the other experimental shapes seemed to prevent the tendency to pull the slug through the hole by virtue of the fact that the slug bulged slightly across its width because of its warped shape. Each of these types, however, increased manufacturing cost because of the additional grinding operations to produce the shape. The final punch is shaped as in *Fig.* 2*e*. This gives sufficient shearing action on the paper and also has no tendency to pull slugs through the hole. This part is also cheaper to manufacture than any of the other designs.

Punching operations demand that the card move intermittently from one punching position to the next and remain stationary while the punch is being driven

through the card. To eliminate the possibility of the card being out of registration while being punched, due to the inertia of the mechanism and the card, a geneva gear is used for gradual acceleration and deceleration of the feeding rolls. This is shown in *Fig.* 3.

Rated in cards-per-minute, the capacity of the machine demands that the card present itself to the die station for punching each row of holes at the rate of 1400 per minute. The driving element in the geneva combination travels one revolution for each row of holes punched, or at the rate of 1400 revolutions per minute. This shaft is driven directly from the motor through a V-belt, which requires very little reduction in speed from the normal speeds of commercial motors, thereby eliminating the necessity of any speed reduction device. The driven element has seven slots and therefore travels two revolutions for fourteen rows of punching, which constitutes a complete cycle of operation and is representative of the work necessary to cause one card to be completely punched.

Requires Accurate Roll Diameters

Uses made of the cards require that there be no appreciable error from one row of holes to the next. This is taken care of in respect to the rows on one card by the extremely accurate diameter to which the feed rolls are held. To be sure that there is no error in the relation of the rows of holes on different cards, each card is started through the machine in definite distance relation to the die at the start of each punching cycle.

When the holes in the master card are sensed, electromagnets are energized and cause corresponding interposers to be pulled into the path of the punch bail, which is operated by the eccentric shaft shown in *Fig.* 5. If for any reason the interposer does not completely position itself, so that its driving surface is entirely in contact with the punch bail, it might be possible for the bail to catch only the corner of the driving surface and slip off before the punch has been completely forced through the card. Should this be permitted to occur without some yielding member to absorb its movement, there would be a resultant breakage of the punch and interposer, and also a possible injury to the driving surface of the punch bail. To provide for this condition, a spring rest pawl was incorporated in each position, so designed and located to absorb a counterclockwise movement of the punch interposer.

With this safety precaution, the most that could happen should the condition occur as described is a failure to punch the hole. This failure to punch is detected at a later time in the machine cycle through the medium of a comparing device, which, as its name implies, compares each card that has been punched with the master card to see that all holes have been punched.

This device is a unit consisting of a group of magnets and latches associated with each column to be checked. On the core of each magnet there are two wound coils. The individual sides of one of each of the coils are wired to receive impulses from holes punched in the master card. The individual sides of the other coils are connected with opposite polarity, and will receive impulses from holes punched in the detail cards. When a hole in the detail card corresponds to a hole in the master card, there will be a concurrent energization of both coils in that particular column.

Due to the fact that the windings of these coils are opposed, the magnetic field of one coil is nullified by the magnetic field of the other coil, and there will be no movement of the armature and consequently no latch released. If, however, there is a hole in either card which is not matched by a similar hole in the same column, there will be an energization of only one of the coils and the armature will release its latch.

Release of any one of the latches in the unit causes

(*Continued on Page* 112)

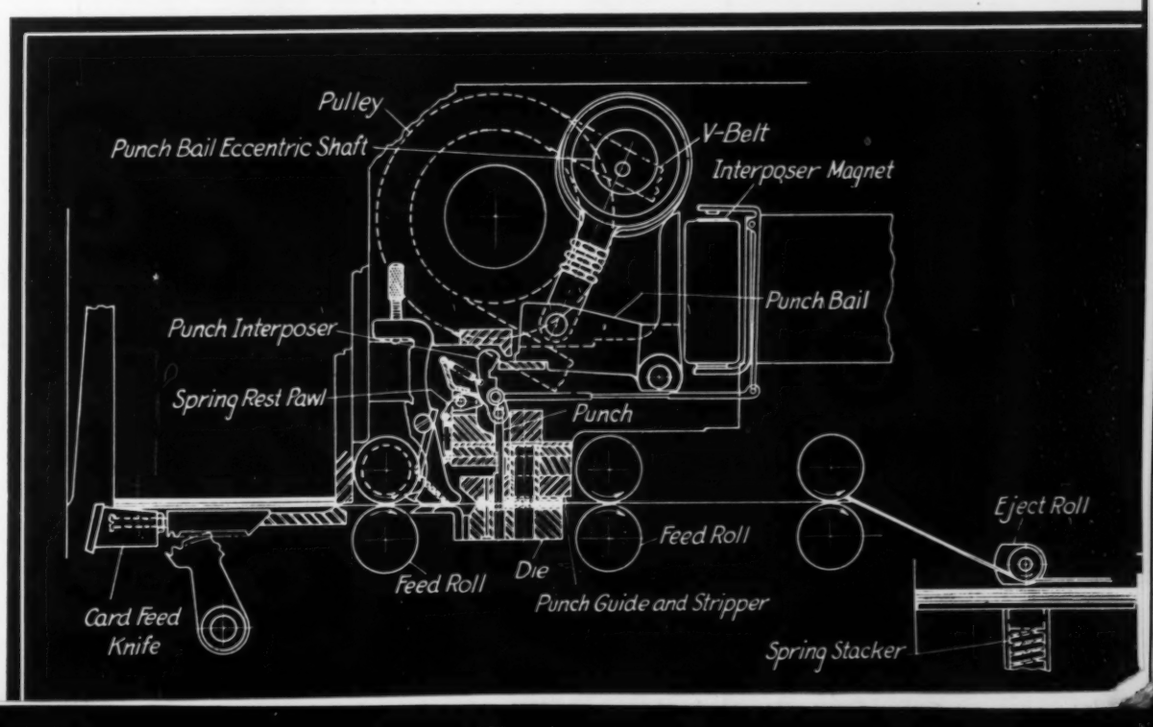
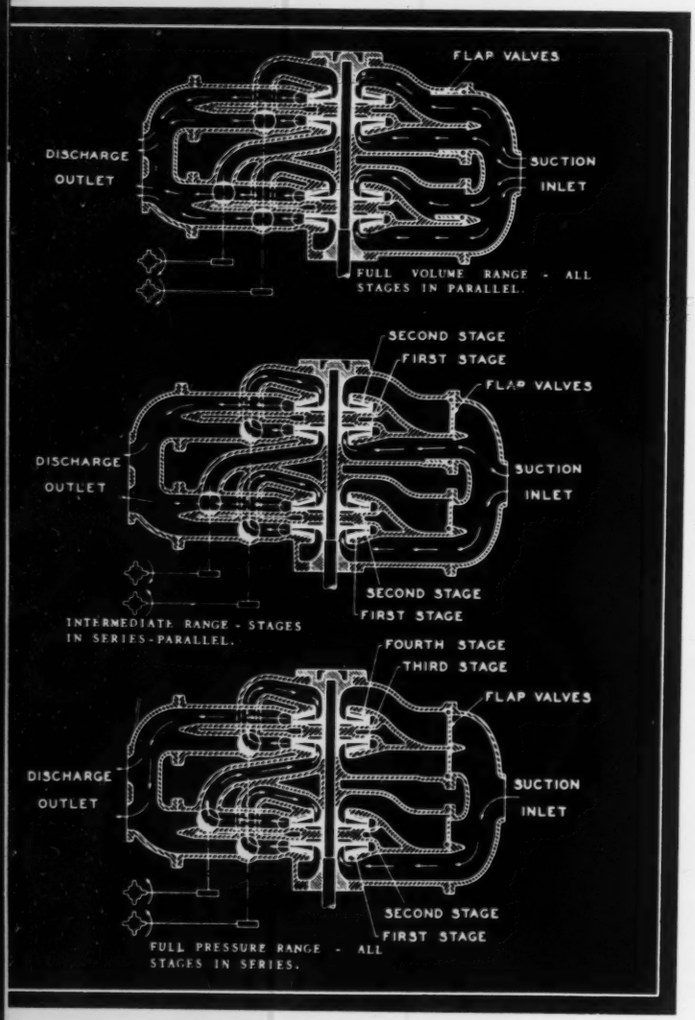


Fig. 5—Arrangement of punching mechanism. Interposer magnets corresponding to electromagnets which are energized by original cards initiate punch operation

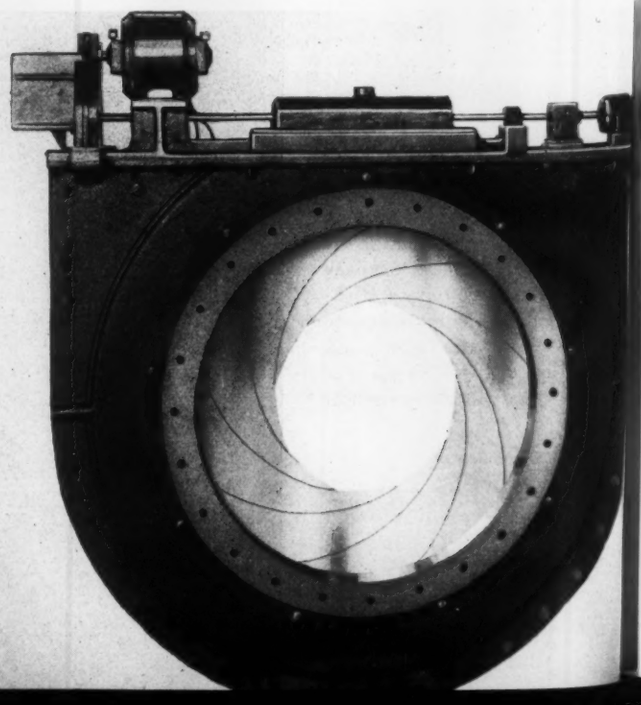
Scanning the Field For Ideas



Three-range pressure-volume Mack pump for fire apparatus combines efficiency with flexibility by providing full capacity at normal pressure, medium capacity at medium pressure or half capacity at double pressure. Change from range to range is made by turning a rotary valve whereby the stages may be connected in series, series-parallel or parallel relation as shown in the drawings.

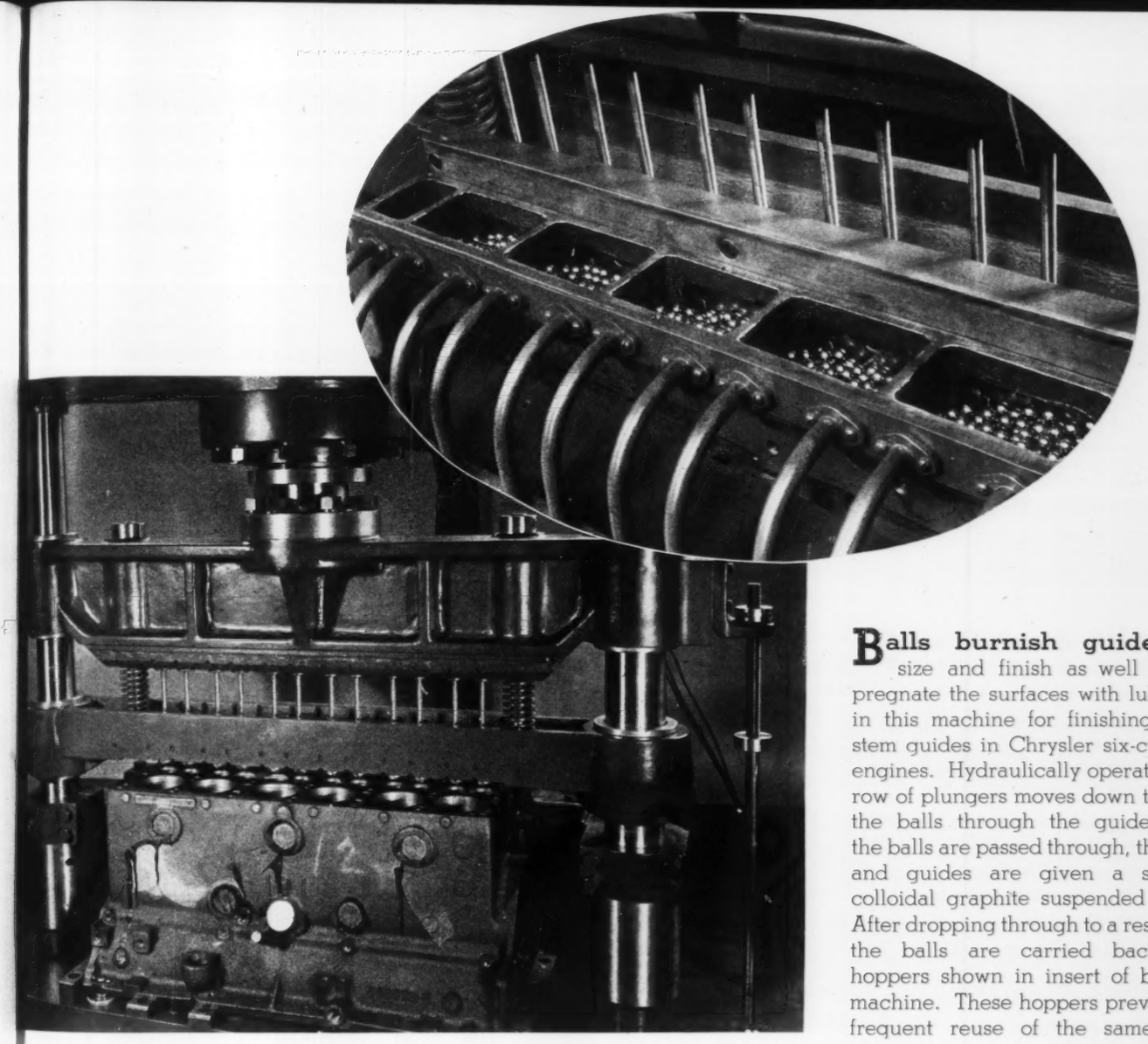
Mounted on a single stainless steel shaft the impellers are tough phosphor-bronze of the volute type. Thrust is practically negligible because each pair of impellers is oppositely faced. Horizontally split casing includes both suction and discharge manifolds and all interstage connections. The pump is driven by a train of three gears, comprising a driving gear in the pump transmission, a large idler and a driven gear on the pump shaft.

Joining the casing with the gear housing is a cage which encloses the stuffing box located to drain outboard any leakage water. Similarly any leakage of grease from the bearings could not under any circumstances be drawn into the pump. An automatic pressure regulator comprises a hydraulic governor with a diaphragm working on a spring-loaded piston. Pressure from the pump discharge actuates this piston through the diaphragm, controlling engine



Variable orifice, similar in principle to the well known camera iris shutter, meters gas or air with a uniform velocity and allows unthrottled operation on the suction side of the fan. Designed by the York Oil Burner Co., micrometer adjustment is obtainable through the motor and worm gear drive at the top of the unit.

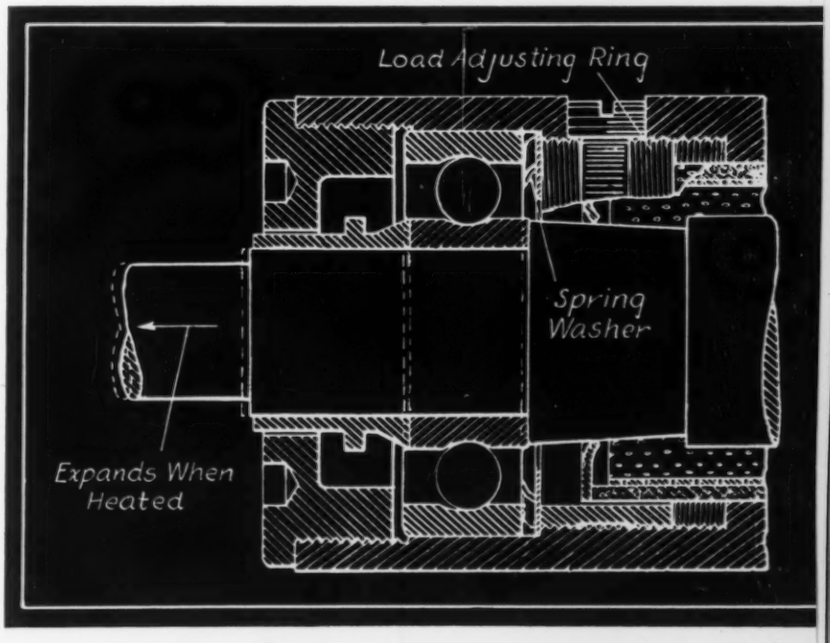
Casing is nichrome iron and the segments are 18-8 stainless steel, cadmium plated. Cam and rack have a 10-pitch tooth for operation of shutter with the rack slide milled into the casing proper. The rack shaft contains a Garlock packing with a nichrome packing gland

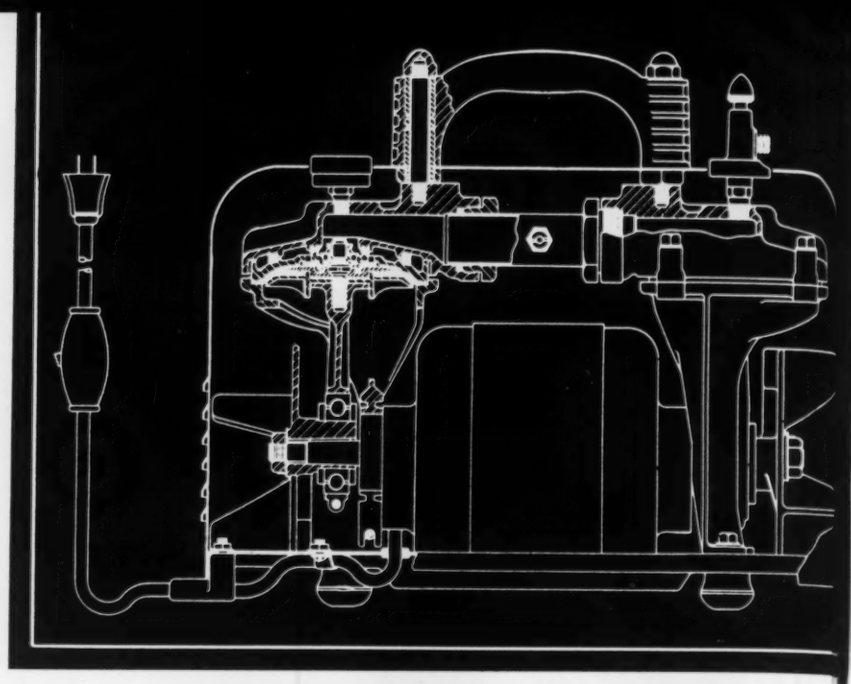


Balls burnish guides for size and finish as well as impregnate the surfaces with lubricant in this machine for finishing valve stem guides in Chrysler six-cylinder engines. Hydraulically operated, the row of plungers moves down to force the balls through the guides. As the balls are passed through, the balls and guides are given a shot of colloidal graphite suspended in oil. After dropping through to a reservoir, the balls are carried back into hoppers shown in insert of back of machine. These hoppers prevent too frequent reuse of the same balls

Compensating for expansion caused by heat this preloaded ball bearing designed by the Dumore company provides long bearing life and precision performance at a wide variety of speeds. At the wheel end of the quill the outer bearing raceway is locked so that all expansion of the shaft is in one direction.

Amount of preload is determined by a short, stiff spring adjusted by an internal nut in the quill tube. With the preload spring located on the inside edge of the outer bearing raceway, the pressure due to expansion is counteracted by the spring so that the pressure on the bearing decreases at high speeds, increases at low speeds. This arrangement permits the bearing to run freely at high speeds with a minimum amount of wear

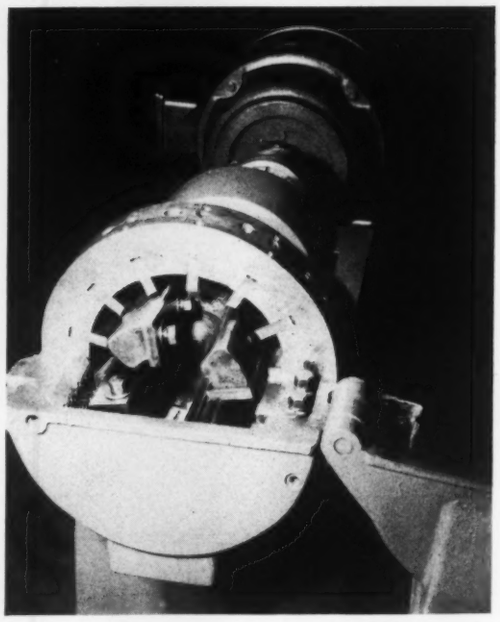




Utilizing double-end motor, this twin diaphragm compressor for paint spray equipment is a compact and portable unit with maximum air pressure for its weight and size. Crank eccentric, flywheel and fan are a single casting mounted on tapered motor shaft with key and locknut. The fans at each end supply strong draft through case to effect "forced draft cooling". Designed by Binks Mfg. Co., this unit delivers three cubic feet of air per minute at 40 pounds with a 1/3-horsepower motor, thermal overload

Rotating knives grind and granulate materials such as plastics, fibrous materials, numerous chemicals, grains and seeds in this machine designed by the Cumberland Engineering Co. Simple and sturdy in construction, the heavy shaft containing four rotating knives is supported on a double row of ball bearings protected by labyrinth seals. The lower half of the grinding chamber has a stainless steel discharge screen.

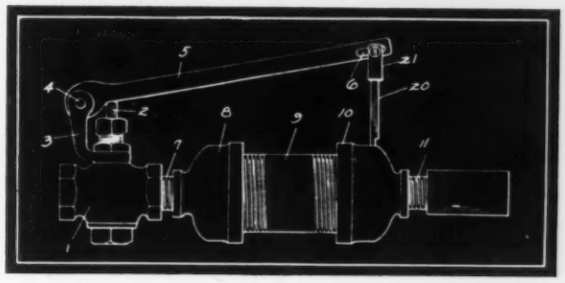
Attached to the machine end casing and extending across the width of the screen, a stationary mangling knife partially reduces material as it enters the cutting chamber. This partially reduced material is crowded into the region of the ring of stationary knives where most of the cutting takes place. Owing to the rapid agitation, the finer particles move out toward the screen and sift through



Combination of tapered and ball bearings provide an unusual, efficient drive for this vegetable peeler designed by the Reynolds Electric Company. The upper bearing, a tapered roller bearing, shown in section, carries the entire thrust of the head. The lower bearing, immediately above the bell gear, is a ball bearing floating on the shaft and carrying radial load only.

Motor drives a bell gear through a quiet operating plastic impregnated canvas pinion to turn abrader disk. Vegetables to be peeled are rolled around, scraping between wall and disk on abrasive consisting of quartz, sand and cement centrifugally molded. This removes skin in fine particles which is washed off with a water spray and carried away by bowl in lower compartment

Fig. 1—Original form of device submitted by inventor to company



Outside Inventions Often Foul Developments

By George V. Woodling

IF AN inventor submits his unpatented invention to a company without any solicitation on the part of the company, he has little recourse in the event that the company begins to appropriate it. On the other hand, if he submits his invention *in confidence* or under conditions which may be construed as a pledge of secrecy, or under an agreement not to appropriate the invention, then he may have recourse and may recover damages if the company inequitably appropriates the invention. The basis for such recovery or suit is on the theory of a *breach of trust* and not upon any patent right. The appropriated features need not rise to the full dignity of patentable invention but must be something more than public or common property and be of such value as to enable the company to profit thereby. The following statement taken from a leading decision is illustrative of the attitude taken by courts in dealing with such problems:

> "The general rule, of course, is that the monopoly of a patent which entitled a patentee to damages for infringement commences only when the patent is granted; but where, in advance of the granting of a patent, an invention is disclosed to one who, in breach of the confidence thus reposed, manufactures and sells articles embodying the invention, such person should be held liable for the profits and damages resulting therefrom, not under the patent statutes, but upon the principle that equity will not permit one to unjustly enrich himself at the expense of another . . . . It would be a reproach to any system of jurisprudence to permit one who has received a disclosure in confidence to thus appropriate the ideas of another without liability for the wrong."

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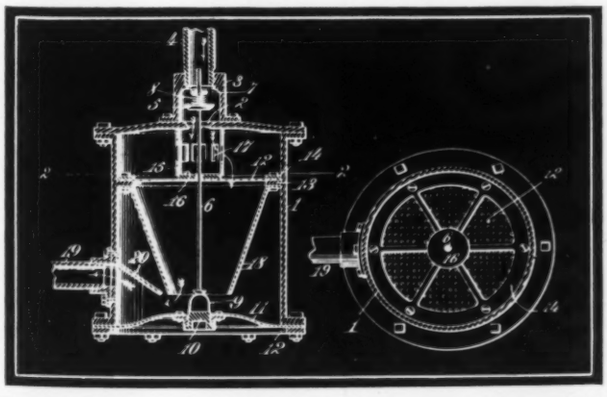


Fig. 2—Company's prior device which a court later held did not embody inventor's principle

Protection afforded by confidential disclosures is limited in that only the company which so received it can be held to account. Should other companies learn about the invention in any lawful way they may use the unpatented idea or device. Some companies will not inspect an outside invention until patents actually are issued thereon because they might be developing a similar device. Later, when the invention is introduced upon the market, the inventor may feel that his ideas were appropriated when in fact the company was acting within its rights. Then too, an imaginative inventor may be tempted to assert that he disclosed more to the company than was actually the case. In any event, the company is placed in an embarrassing position and should follow the practice of exercising caution in the inspection of inventions submitted to it by others.

Confidential Disclosure Implied

One of the main defenses a defendant company usually pleads in cases involving the inequitable appropriation of an invention is that there was no confidential relationship existing between the inventor and the company with respect to the disclosure of the invention. It is not a complete defense to prove that there was no expressed agreement because the court

may find that there was an implied agreement of confidence.

Question of implied agreement arose in a case involving the automatic fire check shown in *Fig.* 1 for the prevention of ignition of gas and air mixture in pipe lines. The inventor wrote to the defendant company asking if it were interested in an invention to overcome certain defects in the prior art. The defendant company replied that it was interested and would send a representative to confer with him. This representative upon making the call learned that the device was not covered by a patent application and declined to look at the device. Further, he refused to permit the inventor to describe it to him but advised the inventor to apply for a patent and send a copy of the application papers to him after filing was recorded. The inventor complied with this suggestion.

Manufactures Without Agreement

After the application papers were received, the company's president replied to the inventor in a manner which typifies a general negative attitude possessed by some companies in passing upon outside inventions. The following abstract from the letter illustrates this point.

> "It seems that you have incorporated no new feature in this fire check, but, on the contrary it comprises all the features of our backfire preventer which is now in common use on our gas apparatus.
>
> "The writer cannot see that there is any invention in your device and certainly no patent claims of any consequence can be procured in view of the present art and particularly the patent controlled by our company. (See *Fig.* 2).
>
> "The writer also considers the fire check inoperative. There is one very objectionable feature which will prevent its acceptance by the insurance authorities and prevents its being dependable.
>
> "Our representative will be in New York within the next few days and we have asked him to call on you and discuss this matter personally.
>
> "We return herewith your patent, drawing and copy of specifications."

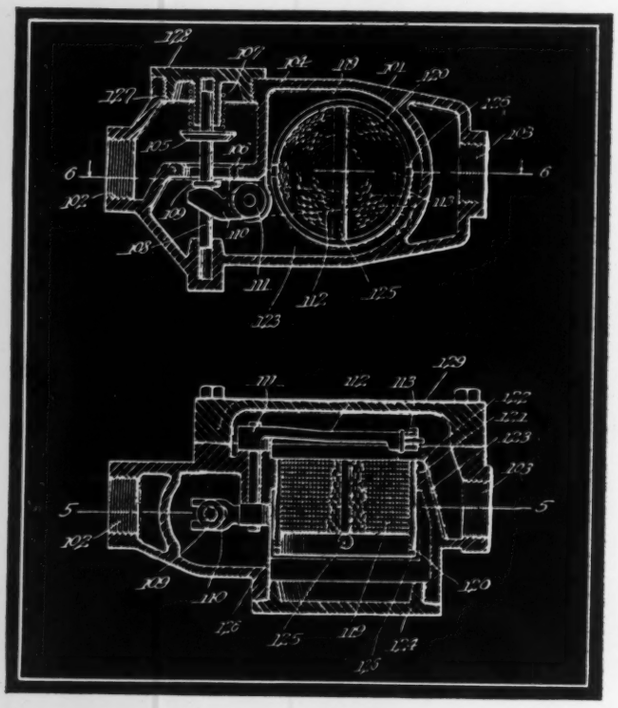


Fig. 3—Redesigned device developed by the company for commercial exploitation

Inventor's Claims Upheld

Notwithstanding the implications in the letter, defendant sent a representative to call on the inventor to negotiate for the purchase of his patent. Nothing came of these negotiations. Subsequently, the company, thinking it was acting within its legal rights particularly in view of the fact the inventor's device was not patentable, started to manufacture and sell the device shown in *Fig.* 3. The court, however, later found it was substantially equivalent to the inventor's device except for commercial improvements.

Judging from the above circumstances, together with the letter which briefly represents the facts of the case, one would be inclined to conclude that the inventor has no recourse for damage for the appropriation of the invention because the inventor submitted the invention to the company of his own free will. But the following is what the Circuit Court of Appeals said in passing upon the question.

> "It is argued that there was no confidential relationship existing between complainant and defendant with respect to the disclosure of complainant's invention; but this contention is groundless. Complainant offered to disclose his invention to defendant with a view of selling it to defendant and so stated in his letter. Defendant was interested in the proposition and invited the disclosure, otherwise it would not have seen complainant's specification and drawings until the patent was granted. While there was no express agreement that defendant was to hold the information so disclosed as a confidential matter and to make no use of it unless it should purchase the invention, we think that in equity and good conscience such an agreement was implied; and having obtained the disclosure under such circumstances, defendant ought not be heard to say that there was no obligation to respect the confidence thus reposed in it."

Some companies use forms of which the following is an example to protect their rights against a case of confidential disclosure from an outside inventor. In these instances the inventor is required to sign agreement before being entitled to submit his invention to the proper officer of the company.

Memorandum Relation to Inventions Submitted to Company by Outside Inventor

.....(date)

The X. Y. Z. Company
Cleveland, Ohio
Gentlemen:

I wish to submit to your company for your consideration a certain invention which I have conceived relating to (Insert name or nature of invention)

.....

.....

It is my understanding that your company is willing to consider all suggestions which may be made to it by outside persons, but because of the possibility that your company's engineers might have already made substantially the same invention or are now working on the same and of the large number of

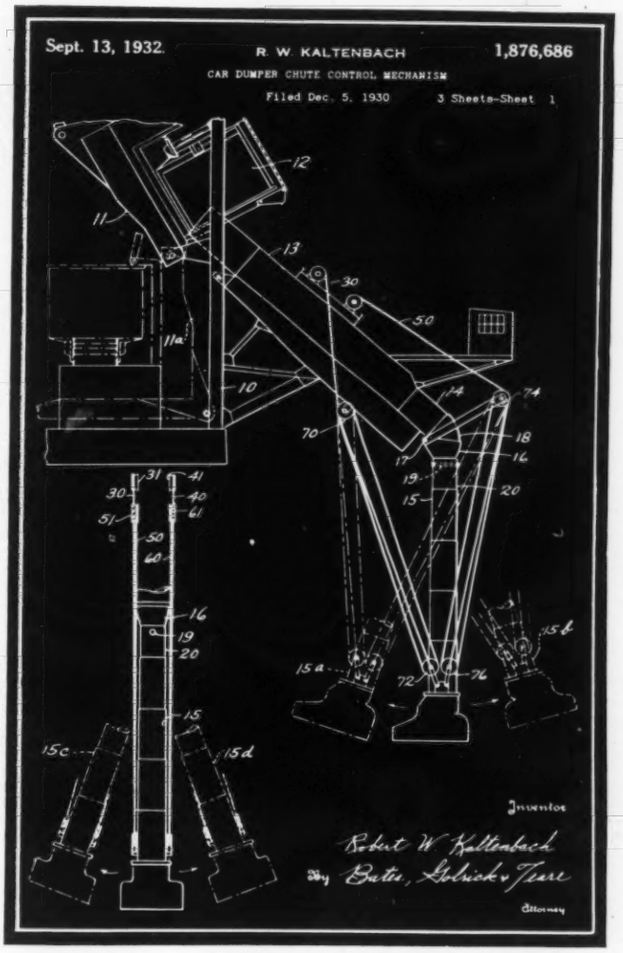

Sept. 13, 1932. R. W. KALTENBACH 1,876,686
CAR DUMPER CHUTE CONTROL MECHANISM
Filed Dec. 5, 1930 3 Sheets-Sheet 1
Inventor
Robert W. Kaltenbach
By Bates, Golwick & Teare
Attorney

Fig. 4—Drawing embodying invention on which notice appeared establishing a basis for a confidential disclosure

such suggestions which are submitted from people in all walks of life of every temperament and disposition, your company requires the acceptance by me of certain conditions before considering my suggestion. These conditions are:

1. The X. Y. Z. company is willing to consider any suggestion which may be made, but does so only at the request and invitation of the person who has the suggestion.
2. No obligation of any kind is assumed by, nor may be implied against, The X. Y. Z. company unless or until a formal written contract has been entered into, and then the obligation shall be only such as is expressed in the formal written contract.

I am agreeable to these conditions and ask you to consider my suggestion under them.

Yours very truly,

(Sign here) .....

Procurement of such a memorandum safeguards the position of the company should the inventor later attempt to recover damages for the unlawful appropriation of an alleged invention. On the contrary, the inventor's position is made strong if he can obtain an acknowledgment from the company that the invention is submitted in confidence. If the inventor desiring to protect his invention by confidential disclosure submits the invention to the company in letter form, it is necessary to state in the letter that the invention is being submitted in confidence or words to the same effect. In the case of an oral disclosure, it is a good plan for the inventor to have witnesses to corroborate his testimony if he is called upon to prove that the invention was disclosed in confidence. Usually it is difficult for the inventor to submit his invention in confidence, because most large companies are advised by their counsel not to accept any inventions in confidence.

Protected by Note on Drawing

Notice on an inventor's drawing or blueprint, *Fig.* 4, may form the basis for a confidential disclosure, such, for example, as the following where the court found little difficulty in awarding damages.

> This drawing is the property of X. Y. Z. company. It shall not be copied or duplicated in any manner, and shall not be submitted to outside parties for examination without our consent. It shall be used for reference to work under contract or proposals submitted by this corporation only.
>
> X. Y. Z. Company
> Cleveland, Ohio

The problem of a company protecting its interest with reference to confidential disclosures submitted to it from the outside is not limited to individual inventors but also embraces disclosures made by one company to another through its representatives.

To protect its own interests and avoid costly suits arising from possible appropriation action from an outside inventor, a company may do well to consider the adoption of an attitude of co-operation rather than to open up negotiations with a negative attitude. If the invention has merit, later possible involvement may thus be avoided.

Correct Curvature Preserved

High rigidity is necessary in the vanes of this one-piece cast steel impeller for a hydroelectric turbine, to preserve correct curvature in relation to the hub. Weighing 13,250 pounds, this casting was produced by Commercial Steel Casting Co., Marion, O. and will be used in the construction of the Shasta Power plant.

Compactness, Redu

By C. G. Troxler
The Hoover Company

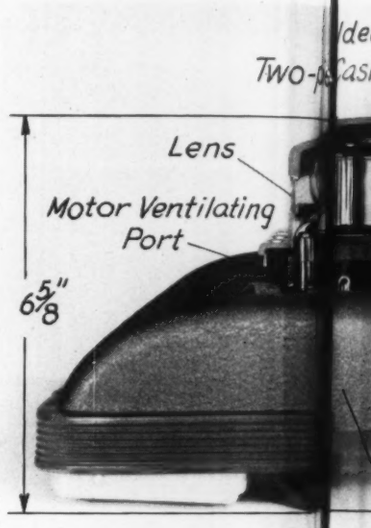
COMPACTNESS through reduced height and elimination of operating noise are two outstanding goals achieved in the design of the Hoover Model 60 electric vacuum cleaner. For the most part these aims are attained by simplicity and absence of complicated mechanisms. They augment the external appearance of the machine and also increase its utility.

Styled by Henry Dreyfuss, the cleaner's main casting is finished in brown ripple enamel, the motor hood is brown phenolic with gold trim and all other parts are brown to match the main parts. A rayon protective cover with woven-in letters is used with the destroyable bag.

Use of ripple enamel on main castings was started several years ago by Hoover and it has proved highly successful. An intensive study was previously carried on in collaboration with paint companies before a finish was developed with the requisite qualities of uniformity of texture, good adhesion and high resistance to abrasion. Other design features of the machine are illustrated and discussed in the following

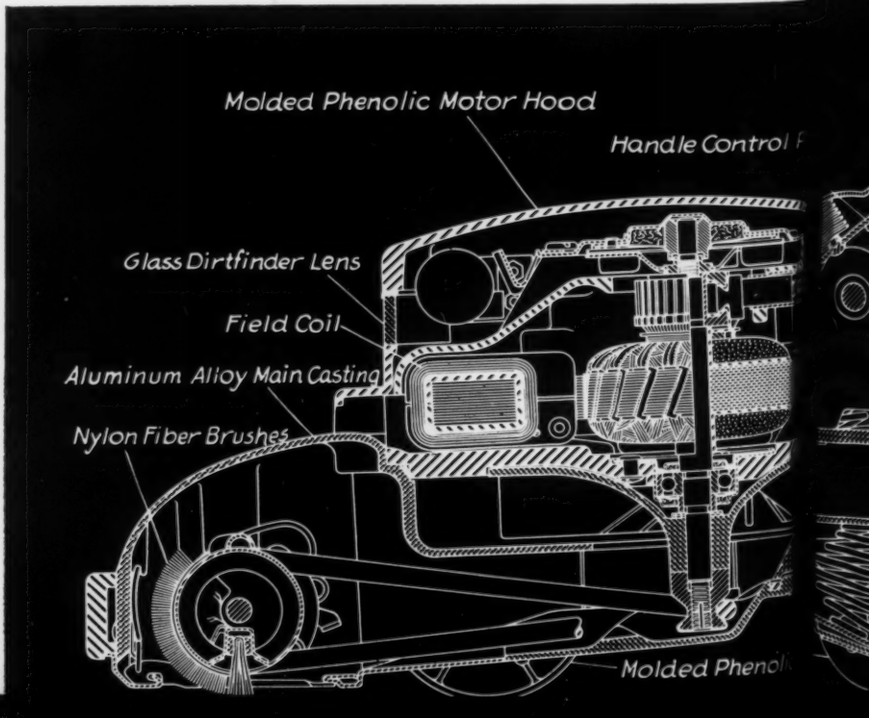
A CROSS-SECTIONAL VIEW through the cleaner equipped with the Hygienisac unit is at right. Details of features shown and explained with the accompanying photographs may be seen. The compactness of the motor and fan system is especially evident, indicating the methods by which height is reduced appreciably

CUTAWAY at right clearly shows compactness of the motor and housing. An effort was made to reduce overall height as much as possible, the final result being a height of 6⅝ inches, more than one inch less than previously. Largest contributing factor in this reduction is the motor, of the Unicoil type in which the field stack is U-shaped with a single field coil wound on the base of the U. This construction permits placing the field coil in such a position that no interference occurs with other parts of the motor. Height of the field stack is reduced to .6-inch as compared to about .9-inch on previous models.

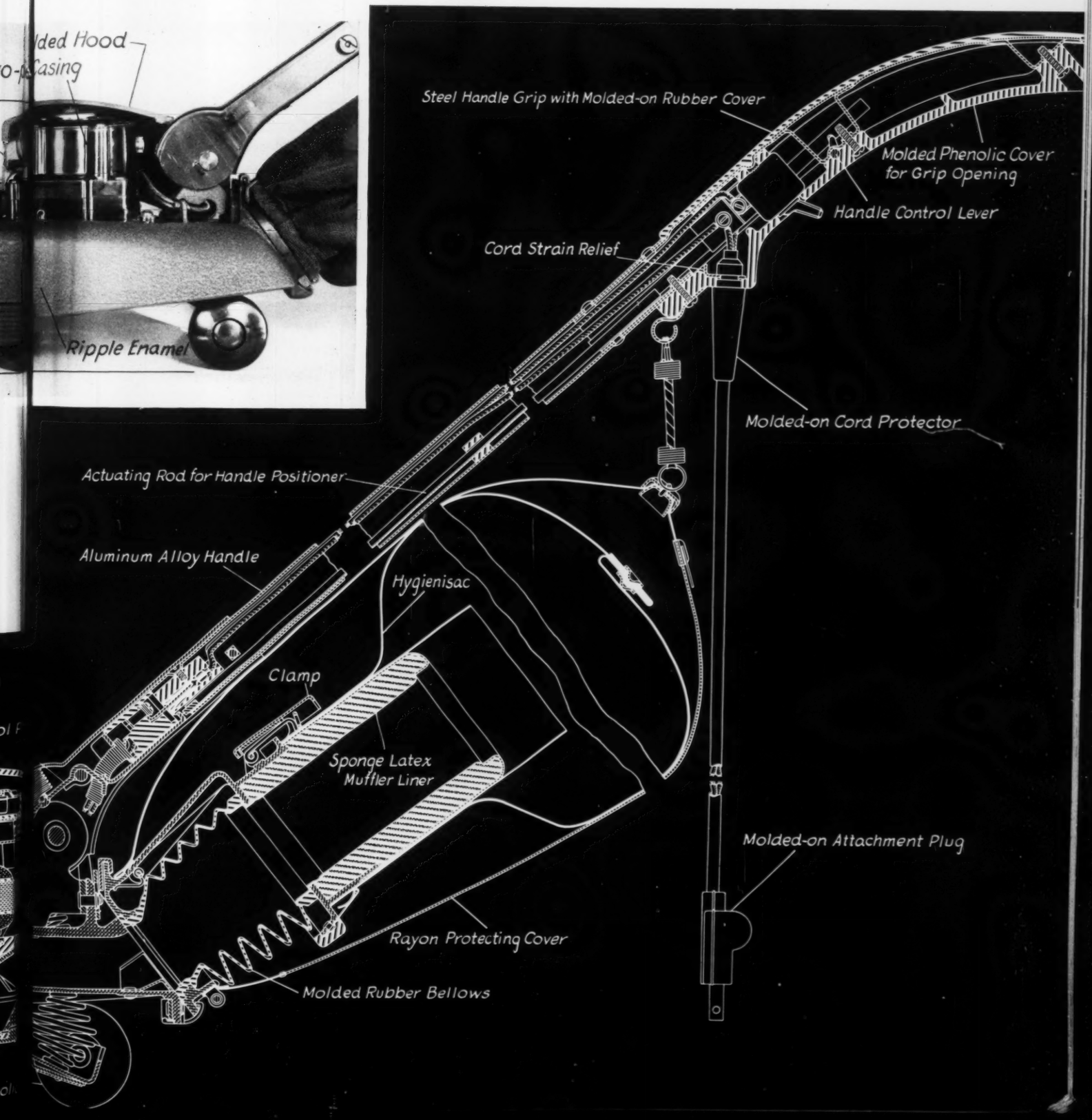


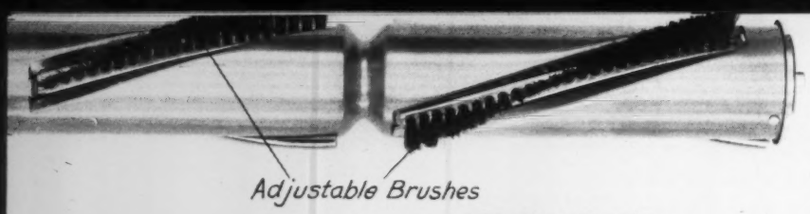
In order further to decrease height the usual handle bail is eliminated by pivoting the handle socket at the rear of the cleaner, and the parts are designed so the handle may be lowered parallel to the floor. In this position the socket is even with the top of the motor hood, allowing cleaning under low furniture.

Another feature shown in this photograph is the glass lens mounted in front of the dirt finder lamp. This lens directs the band of light downward to the most advantageous point



...ed Noise Achieved in Domestic Unit





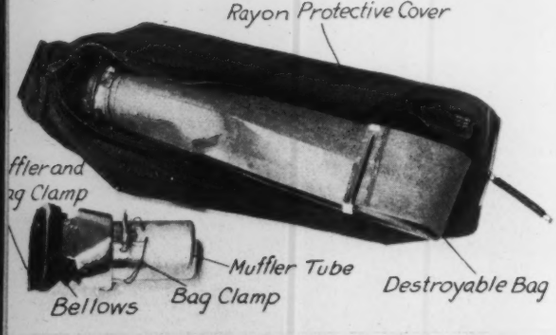
SECOND MOST OUTSTANDING feature of the machine is reduction in operating noise, several factors contributing to this. The greatest gain was made by the use of the rug vibrator shown in the photograph above. Previously brushes were arranged in a plane parallel to axis of rotation. In the new design the brushes are placed on a helix, this arrangement effecting an appreciable reduction in noise while maintaining efficient cleaning.

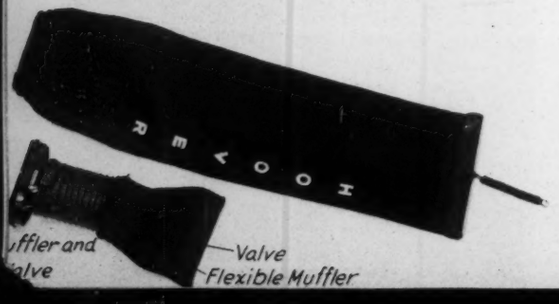
One of the problems solved in the development of the rug vibrator was in forming the aluminum alloy brush backs in a helical shape. Various methods were considered, including rolling and forming, but a method finally was developed whereby the brush backs could be die cast in the finished shape. The longer of the two brushes has 25 tapered tuft holes equally spaced in a helix angle of 115 degrees. Each of these must be made by a core which is pulled at an angle of almost five degrees with the adjacent core. A special grade of Nylon is used

A CLOTH BAG is standard equipment but a destroyable bag is offered as optional. These are shown below, the lower figure being the cloth and the upper the destroyable bag. In each case an exhaust muffler is used.

Muffler liners are molded sponge latex and in the case of the cloth bag the liner is covered with a spring wire reinforcement and a sheet rubber covering, providing a flexible assembly. A spring-closed cloth valve is placed on the end of the muffler to prevent dust from escaping when the bag is being emptied through the upper end.

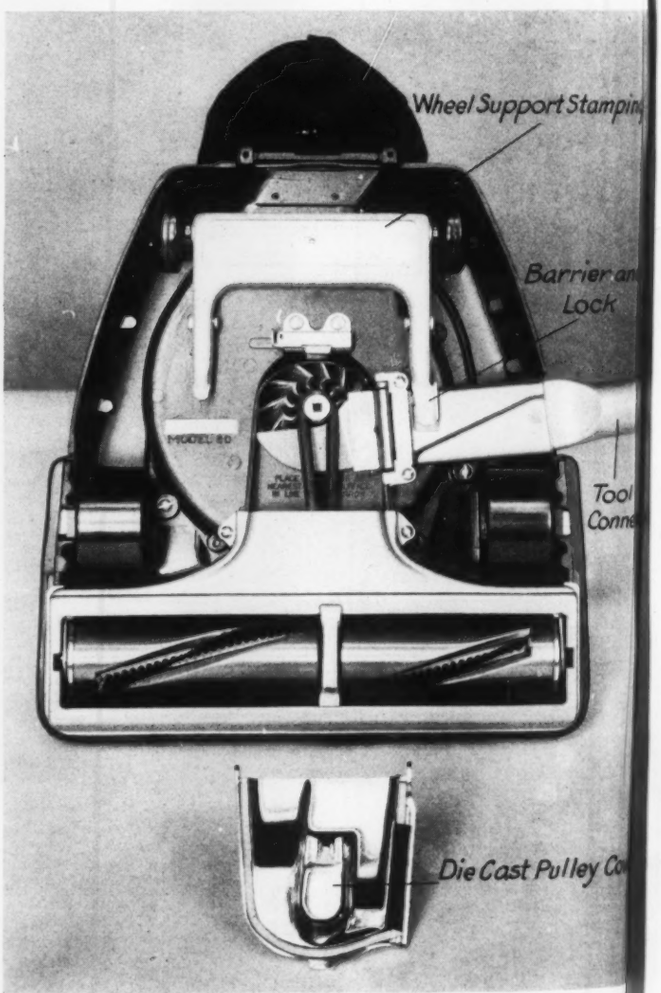
A bellows is included in the destroyable bag assembly between the bag flange and the bag clamp casting. The muffler for this assembly is covered with an aluminum alloy tube wich acts as a pilot for the bag. Called the Hygienisac, the destroyable bag is made of fibre-felt and combines the necessary characteristics of tensile strength, low back pressure, good filtering qualities





BOTTOM VIEW of the cleaner with the cleaning tool connector in place and the pulley cover removed, below, illustrates the simplicity of the design and the lack of complicated mechanisms. Manual adjustment, usually necessary to compensate for different types of floor coverings, is omitted. The cleaner was designed so that the suction nozzle lips would assume the correct position for most efficient cleaning on each type of carpet on which it is used.

The large stamping to which rear wheels are attached is pivoted on the main casting, and springs which cannot be seen in this illustration support the rear end of the machine. In normal operation one leg of this stamping forms a barrier preventing insertion of the cleaning tool connector. Depression of the rear of the cleaner, however, pivots the rear wheel support on the main casting and removes the barrier. When the rear end of the cleaner is released the barrier rests on tool connector, and locks it in place



Basic Principles Applied to Machine Control

By O. G. Rutemiller
Westinghouse Electric & Mfg. Co.

TRENDS in the development of production machines are toward increased automatic cycling. Such machines depend almost entirely on electric control for their operation. In some cases this electric control governs the operation of solenoid-operated valves which in turn control a hydraulic system. In other cases the electric control governs the operation of motors and solenoids which provide the final mechanical movements.

Control for automatic cycling machines is usually involved and appears complex at first glance. It represents, however, a combination of a number of basic circuits. A few of these circuits are discussed in this article with the aid of simplified schematic diagrams. Their careful scrutiny is worth while and they should prove useful for reference purposes. Additional circuit diagrams may be added from time to time as desired.

INCREASING uses of sequence control and the need for an understanding of the basic principles make this discussion particularly timely. Presented before the Machine Tool Electrification Forum this selection of circuits with simplified schematic diagrams is useful for reference purposes

Alternating-current equipment and simple nonreversing and reversing motor controls only will be considered in this discussion.

In *Fig.* 1 is shown a motor circuit for a nonreversing linestarter. The device *M* represents a three-pole line contactor and *OL* represents heaters in the thermal overload relay. A fourth pole may be added to the contactor for two-phase circuits or one pole may be omitted for single phase circuits. In some cases, three-pole overload relays may be required. Then a third heater is added in the motor circuit. The operating coil may be connected in a number of different ways, a number of which are discussed in the following.

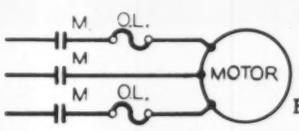


Fig. 1

Illustrated in *Fig.* 2 is the simplest connection used with such a starter. The pushbutton is of the normally-open momentary-contact type. The motor will run in one direction only as long as the pushbutton is held down and the motor will coast to rest when the pushbutton is released.

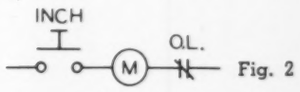


Fig. 2

Known as the "two-wire pushbutton circuit," *Fig.* 3, the pushbutton is of the mechanical held type, that is, a latching mechanism or toggle mechanism holds the button in a given position after it is operated. Since the pushbutton remains closed after the start button is depressed, the motor will continue to run until the stop button is depressed.

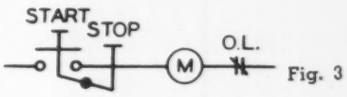


Fig. 3

Such an arrangement is also known as the "low voltage release circuit." In the event of a voltage failure the contactor will drop out, but upon a resumption of power the contactor will be energized and the motor will start without any manual operation. This scheme is dangerous to use on machine tools and similar application because the machine may start inadvertently after a voltage failure and may cause injury to the operator. It may be used on pumps or fans and blowers where there is no danger of injury in the event of an inadvertent start.

In *Fig.* 4 is shown "the three-wire pushbutton circuit" or the "low voltage protection circuit." The pushbutttons are both of the momentary contact spring-return type, one normally open, the other normally closed.

When the start buttton is depressed the contactor coil is energized and the auxiliary contact *N* closes, completing a circuit around the start button. Consequently when this button is released the coil will remain energized. When the stop button is depressed, the coil is de-energized and the opening of the auxiliary

contact places the circuit back in the normal off position.

This circuit provides voltage failure protection since in the event of power failure, the dropping out of the contactor *M* will also open the auxiliary contact *N* and it will be necessary to depress the start pushbutton to resume operation upon the return of power. Since this

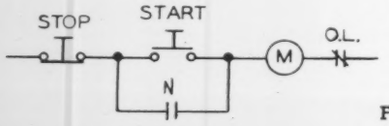


Fig. 4

requires a deliberate operation on the part of the operator there is no chance of an inadvertent start.

In some cases it is desirable to provide a lever for starting the machine rather than a pushbutton. In these cases some type of master switch is used. *Fig.* 5 shows a method of providing low voltage protection with a two-point master switch. This switch is arranged so that as the operating lever is moved toward the start position, contacts *MS*1 and *MS*2 close, completing a circuit to the starter coil. Further movement

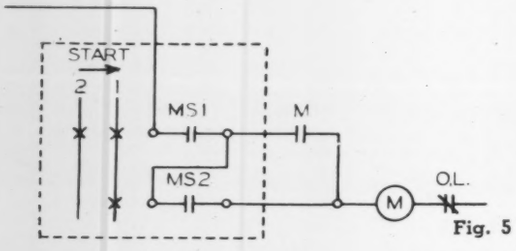


Fig. 5

of the operating lever in this same direction opens contact *MS*2 but the coil remains energized through the auxiliary contact *M*. When the operating lever is moved to the off position, *MS*1 and *MS*2 are both opened and the coil is de-energized.

In the event of a voltage failure when the operating lever is in the run position, the contactor will drop out and will not be energized until the master switch is manipulated again to close contacts *MS*2.

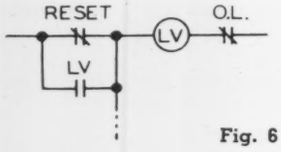


Fig. 6

Another method of providing under voltage protection is by the use of a low voltage relay. *Fig.* 6 shows the basic form of such a scheme. *Fig.* 7 shows its use in a nonreversing arrangement. With this arrangement the *LV* relay is energized when the master switch is in the off position. The *LV* contact provides a holding circuit. Moving the master switch to the start position energizes *M* through the contact of *LV*. In the event of an overload or voltage failure, the master switch must be moved to the off position to pick up *LV* before the machine can be restarted. Thus, since a de-

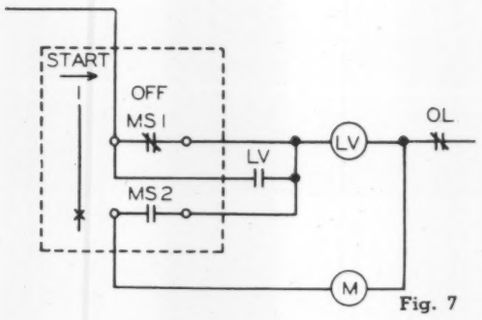


Fig. 7

liberate operation is required inadvertent starting is prevented.

When a machine is operated at times under control of an automatic regulator such as a float switch, pres-

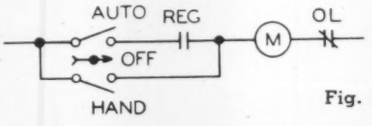


Fig. 8

sure switch, thermostat, etc., the three-position selector switch, *Fig.* 8, is generally used as a pilot control device. When the "hand-off-auto" switch is moved to the "auto" position, the motor will be started and stopped under the control of the regulator. When in the "hand" position, the motor will run as long as the switch is allowed to remain in this position.

This scheme is used frequently in automatic cycling control to provide a means of stopping the cycle and operating the machine manually by means of inching pushbuttons for set-up purposes.

Typical three-wire thermostat circuits, *Fig.* 9, may be used for automatic cycling when the pilot device provides a make contact for both starting and stop-

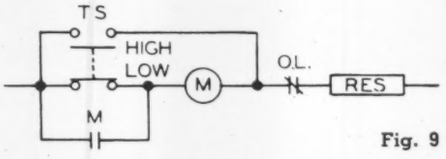


Fig. 9

ping functions. This illustrates a temperature control circuit such as might be used on an oil burner.

When the thermostat calls for heat the "low" contacts are closed, energizing the contact coil *M*. As the temperature increases, the "low" contact will open; however, the motor will continue to run because the auxiliary contacts *M* provide a holding circuit. When the "high" contacts close the coil *M* is shunted causing the contactor *M* to drop out. The resistor limits the current drawn when the "high" contacts close. Coil *M* is usually designed to operate on half line voltage and the resistor has an ohmic value such that it reduces the voltage across the coil to the proper voltage. The resistor must be capable of carrying the current that would flow with full line voltage impressed on it.

On a great many machine tools it is desirable to inch or jog the motor when making a setup. *Fig.* 10 shows

the simplest scheme for accomplishing this. Basically the circuit is the same as the three-wire pushbutton circuit, *Fig.* 4, with a make and break pushbutton added. This inch button is arranged to open the holding circuit of the contactor *M* through its back contacts. When the inch button is depressed a circuit is closed to the contactor coil *M* through its make contacts. The break contacts of the pushbutton open the holding circuit. Thus the motor will run only as long as the button is held down and will stop when the button is released.

This method has one disadvantage. If the inch button is released quickly it is possible to establish a circuit through its break contacts to the holding circuit before the auxiliary contact *M* gets open. This will cause the motor to continue to run, just as if the start button were depressed. For this reason such a connection is not used frequently.

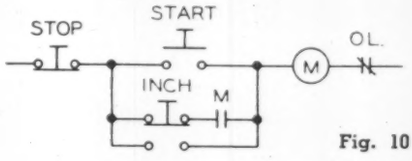


Fig. 10

An inching arrangement that eliminates the drawback of this scheme is illustrated in *Fig.* 11. Instead of a separate inch pushbutton, a two-position selector switch is added. When the selector switch is in the run position the operation is the same as the three-wire pushbutton connection shown in *Fig.* 4. When the selector switch is placed in the inch position the holding circuit through the auxiliary contact *M* is broken and the motor will run only as long as the start button is held depressed.

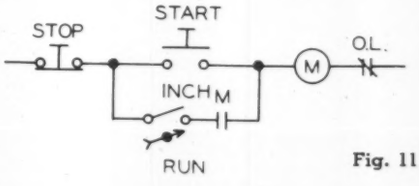


Fig. 11

One disadvantage is that the start button serves two functions, that is, both as a start and inch button. This is not considered good practice as it may lead to incorrect operation.

In *Fig.* 12 is the best inching method and also the most expensive. Here the start button energizes a relay *CR*. This relay establishes its own holding circuit and also establishes a circuit to the contactor *M*. When the inch button is depressed the contactor *M* is energized directly through the pushbutton, and since it has no holding circuit arrangement it will drop out when the inch button is released.

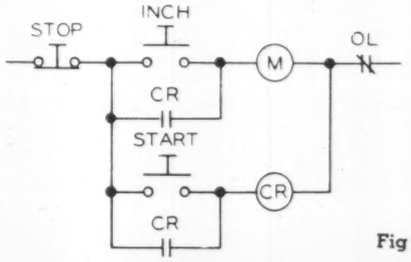


Fig 12

Nonreversing cycling or indexing control is shown in *Fig.* 13. When the start button is depressed the motor will start, a holding circuit being established as soon as the limit switch *FLF* closes. The motor will stop when the limit switch opens. Only requirement is that the pushbutton must be held down until the mechanism has traveled far enough to close the limit switch.

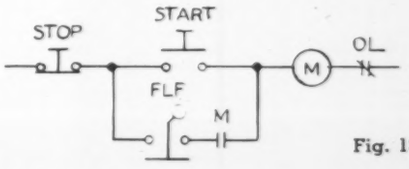


Fig. 13

This illustration, *Fig.* 14, shows a nonreversing cycling control which eliminates the objection to the one shown in *Fig.* 13. It requires an additional limit switch and a control relay. Here, the limit switch *LS* is arranged to be closed in the stopping position of the cycle, and to open its contacts sometime during the cycle. Usually the same cam that operates *FLF* is arranged to open *LS* during the cycle, after *FLF* is reset.

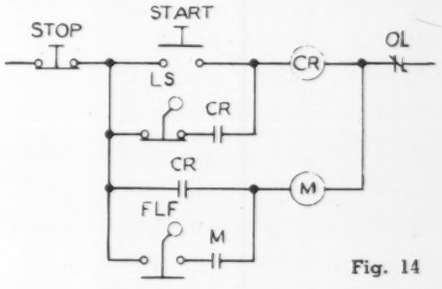


Fig. 14

When the start pushbutton is depressed the relay *CR* picks up and establishes a holding circuit through limit switch *LS*. A second contact on *CR* energizes *M*. As the cycle progresses *FLF* closes, or resets, and establishes its own holding circuit. *LS* is then opened causing *CR* to drop out leaving *M* under the sole control of *FLF*. When *FLF* opens *M* drops out, stopping the motor.

Still another nonreversing cycling control is *Fig.* 15 which eliminates the objection cited in *Fig.* 13, by the use of two control relays. When the start button is depressed the contactor *M* is energized, establishing a holding circuit through the normally closed contact of *CR*2. When the operating cam resets limit switch

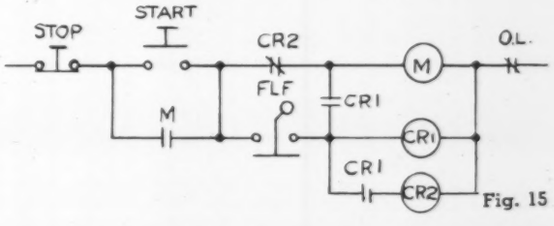


Fig. 15

FLF, the relay *CR*1 is energized. One set of *CR*1 contacts energizes *CR*2. The opening of *CR*2 normally-closed contacts places the contactor *M* under the sole control of limit switch *FLF*. When the *FLF* opens it drops out all relays and the contactor.

This is usually the most economical circuit to use because the relay *CR*2 can be used to start a following sequence of operations. When used for this purpose it usually is best to use a mechanically held relay. This eliminates any possibility of *CR*2 normally-closed contacts closing before the *M* auxiliary contact opens at the end of the cycle.

Controls for Reversing Duty

For a reversing line-starter the motor circuit only is shown in *Fig.* 16. This motor circuit applies to the following illustrations.

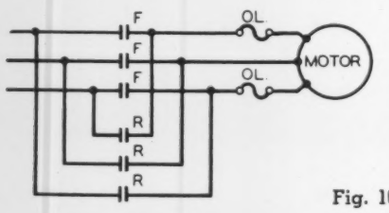


Fig. 16

Simplest and most usual form of a reversing magnetic starter circuit is illustrated in *Fig.* 17. It amounts to a combination of two nonreversing three-wire pushbutton controls with a normally closed auxiliary contact in each contactor coil circuit. These auxiliary con-

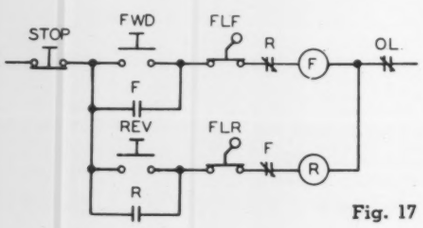


Fig. 17

tacts are desirable but not necessary. They provide electrical interlocking between the contactors. The limit switches may or may not be used.

A better scheme for a reversing starter is *Fig.* 18 because it provides pushbutton interlocking, in that if both buttons are depressed at the same time no cir-

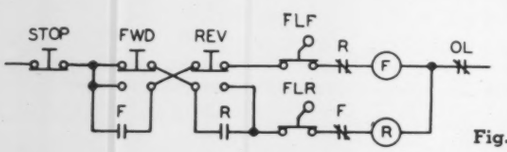


Fig. 18

cuit is established. With this circuit it is also possible to reverse without first operating the stop button.

In *Fig.* 19 a reversing starter provides reciprocation from limit switches. This is the basic directional scheme used on reversing planer drives. When the "auto forward" pushbutton is depressed a circuit is established through the closed contacts of the "auto reverse" button to the control relay *CR*. *CR* establishes its own holding circuit. The closing of *CR* also establishes a circuit through the closed contacts of the auto reverse button and the limit switch *FLF* to the *F* contactor coil. Since the normally-closed contacts of the auto forward button are open there is no tendency for the contactor coil *R* to be energized and the nor-

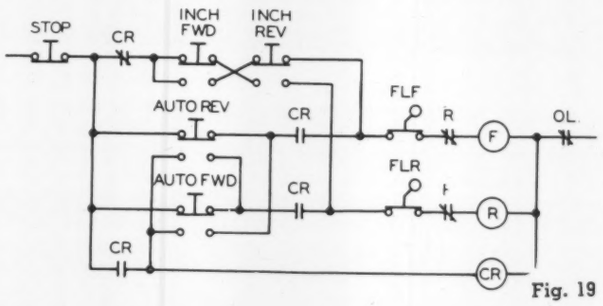


Fig. 19

mally-closed auxiliary contact on contactor *F* prevents *R* from being energized when the auto forward button is released.

The motor may be started in a reverse direction in a similar manner by operating the auto reverse button. When the limit switch *FLF* is opened the contactor *F* is de-energized. The normally-closed auxiliary contacts on *F* close, causing contactor *R* to pick up. This reverses the motor by plugging, thus causing reciprocation. This operation will continue until the stop button is depressed, dropping out *CR*.

The use of a normally closed auxiliary contact on *CR* in the circuit to the inch buttons should be noted. This prevents the contactors from being energized through the inch buttons during automatic operation.

Known as the "tapping machine circuit," *Fig.* 20 provides automatic reversing which stops after one cycle. It is used on reversing tapping machine drives and similar applications. When the forward button is depressed the forward contactor *F* is energized through

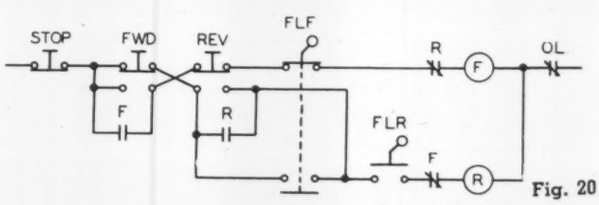


Fig. 20

the limit switch *FLF* and the normally closed auxiliary contact *R*. As the forward part of the cycle progresses the reverse limit switch *FLR* then closes. Its normally closed contacts de-energize the *F* contactor and its normally open contact energizes the reverse contactor *R* thereby plugging the motor. When the reverse limit switch *FLR* operates, the motor is stopped.

The normally-closed auxiliary contacts on *F* and *R* are necessary in this circuit because the high speed of operation of modern snap-action limit switches may complete a circuit to *R* before *F* opens.

Simplest form of a "plug-stop" circuit is shown in

(*Concluded on Page* 106)

Photoelastic Analysis in Commercial Practice

By R. E. Orton
Acme Steel Company

Part IV

TO DETERMINE all pattern fringes required for photoelastic analysis of loaded models, zeros and sufficient other control points are located by progressive loading as discussed in the preceding installment. It should be remembered that these zeros are points of zero principal stress difference, and *not* points of zero *stress*. The condition is that of a "hydrostatic head", as described in Part I. Zeros will not necessarily be present at all, but when they are they afford convenient control points. In models having too high an initial pattern the zeros may not be dark. This condition may be discovered by a few loadings and unloadings of the model.

At times two contours may touch, causing difficulty or even an error in interpretation. This condition may be discovered by increasing the load slightly, when the fringes will take on their separate appearance. It is best to avoid photographing when in this form.

Elastic theory is of immeasurable aid in interpreting photoelastic pictures, and a further study of this subject is recommended. The use of it will be illustrated in the following detailed discussion of the analysis of two pictures.

Simple Beam Provides Check

In *Fig.* 19 is shown a simple beam, .284-inch deep by 2.865-inch span, magnification six diameters, stressed by a concentrated load of 29 pounds applied at 1.465 inches from the left reaction. Load is applied by means of a ⅛-inch hex over a width of .07-inch. The vertical black band is the .02-inch diameter music wire through which the load is applied. This loading permits an excellent check on the accuracy of the photoelastic work.

From progressive loading it is already known that the heavy dark band along the center line is a double fringe, the value of each being 2. It has, in like manner, been determined that the order at the bottom under the load is 17. A check is made by counting from the 2 at the center to the 17 at the bottom. The bakelite plate from which this model was made was calibrated at 86. Therefore, at the bottom under the load, the principal stress difference, Q, is

$$Q = \frac{86}{b} \times 17 = \frac{1462}{b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (20)$$

where b is the thickness of the beam. Since the boundary is here free of load, the only principal stress is parallel to the edge and equal to Q; and from the nature of the loading the stress is tensile.

The conventional formula, Mc/I, where c is distance from neutral axis to extreme fiber, gives for the bending stress $+ 1542/b$. Elastic theory shows that the stress at this point is reduced below that computed by conventional theory an amount equal to $.27P/bd$ where d is the depth of the beam. This gives a reduction in the mathematical figure of $28/b$. Also, correcting for the .07-inch wide distribution of the load gives a further reduction of $19/b$. This now gives for the stress as computed mathematically, $+ 1495/b$, leaving an indicated error in the photoelastic work of 2.2 per cent.

It is of interest to examine the stress at a distance remote from the load. At such a location the stress is quite accurately given by conventional theory. By

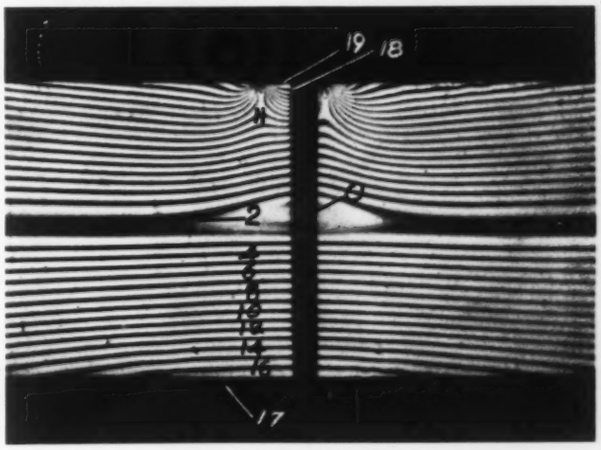


Fig. 19—Simple beam stressed by concentrated load applied with music wire. This is excellent check on accuracy of photoelastic work

combining S_x as obtained from My/I with $v_{xy}=3P(1-y_1^2)/4bd$, (parabolic distribution of the shear), the following expression is obtained,

$$Q=\frac{3P}{2bd}\sqrt{B^2x_1^2y_1^2+(1-y_1^2)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (21)$$

where x is measured from the end reaction, y is measured from the center line of the beam, $x_1=x/(\frac{1}{2}l)=2x/l$, and $y_1=y/(\frac{1}{2}d)=2y/d$, $B=l/d$, and l is the beam span. The fringe order n will be given by,

$$n=\frac{Qb}{H}=\frac{3P}{2Hd}\sqrt{B^2x_1^2y_1^2+(1-y_1^2)^2} \quad \ldots\ldots\ldots\ldots (22)$$

At the center line y_1 equals zero, substitution in Equation 22 gives $n=3P/2Hd=1.78$. Along the center line then, at points away from the disturbance of the load and the end reactions, the fringe value is constant. Close observation of the picture will disclose a faint light line along the center, the level 1.78.

At the top and bottom n reduces to,

$$n=\frac{3PB}{2Hd}\,x_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

The fringe value varies directly as x_1. Examination of the picture discloses a uniform spacing of the ends of the fringes, confirming this variation.

At the depth of the beam away from the load, a

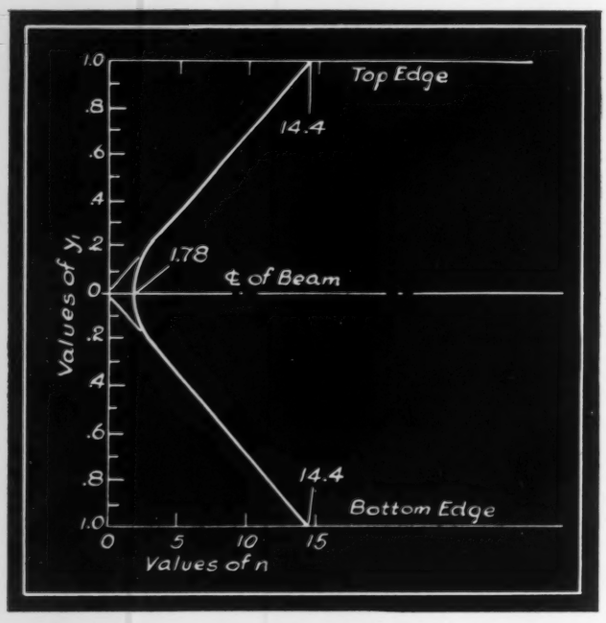


Fig. 20—Fringe values measured from center of beam

point well removed from its disturbance, Equation 22 reduces to,

$$n=\frac{3P}{2Hd}\sqrt{(B-2)^2y_1^2+(1-y_1^2)^2} \quad \ldots\ldots\ldots\ldots\ldots (24)$$

Fig. 20 is a plot of this equation. Comparison of values obtained from the equation with those from the picture show very good agreement. For instance, at the lower and upper edges $n=14.4$. The picture shows at the lower edge 14¼, and at the upper 14¾.

It is interesting to examine the principal directions and stresses along this section. S_1 will be taken as the horizontal principal stress at the bottom. S_2 then is vertical and equal to zero. As we rise along the section line the principal directions rotate clockwise, and S_1 and S_2 decrease algebraically. At the center line the directions are at 45 degrees and $S_1=-S_2=\pm v_{xy}$. This is the condition of pure shear. As we procede above the center line the directions continue to rotate clockwise and the stresses to decrease, until at the upper edge S_1 is now vertical and equal to zero, and S_2 is horizontal and maximum in compression.

Some idea mathematically of the stress directly underneath the load is obtained by considering the stress system as made up of a bending stress system combined with that from a load uniformly distributed over part of the boundary of a semi-infinite solid. Since v_{xy} along the center section will be zero in both cases, the principal directions are horizontal and vertical. Considering the horizontal stress as S_1, it will, in the first case, be zero at the center and vary linearly from there to the top. S_2 will be equal to zero at all points. Reference to elastic theory for the second system shows that S_2 is always compressive, increasing numerically to the value of q at the top. S_1 is also always compressive, and less than S_2 until the top is reached where it becomes also equal to q.

Stress Differences Combine Directly

Since the principal directions are the same for the two systems the Q values may be combined directly. The second system, since S_2 is greater numerically than S_1, gives a positive value of $Q=(S_1—S_2)$. The first system, the reverse being true, gives a negative value. As a result the fringe value is reduced below that which would obtain without the contact stress system. This explains the zero point, indicated in the illustration.

At the top the second stress system gives $S_1=S_2$ and therefore $Q=0$. From this the fringe value at this point may be determined by considering the bending stress only. This gives 18 for the computed figure, and the illustration shows 19.

Condition of stress under the load is that given by Equations 15 and 16. The stress difference is given by,

$$Q=19\,\frac{86}{b}=\frac{1634}{b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (25)$$

and q is equal to,

$$q=\frac{29}{.07b}=\frac{414}{b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (26)$$

Substituting in the equations give,

$$S_x=-q\pm Q=-\frac{414}{b}\pm\frac{1634}{b}=-\frac{2048}{b}\text{ or }+\frac{1220}{b} \quad \ldots (27)$$

and

$$S_y=-q=-\frac{414}{b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (28)$$

From the nature of the loading it is apparent that

S_y must be compression, giving for the maximum stress at this point, $-2048/b$. The mathematical figure, computed as above, is $-1937/b$, giving an indicated error of 5¾ per cent. It should be pointed out that the load is probably not uniformly distributed as assumed, and that the equations used in determining the stress mathematically are only approximate.

This load system should prove very useful to the beginner for a comparison of the accuracy of his work. It is suggested that, before attempting any work of importance, such a check be made.

In *Fig.* 21 is a curved link under tension. This shape and loading will serve also as a check on the photoelastic work. At the center of the inside edge, the point of maximum stress, there are 7½ fringes giving photoelastically a stress of $7.5 \times 86/b = +645/b$. By elastic theory it is computed as $+661/b$, by conventional theory as $+442/b$. This indicates an error for the photoelastic analysis of 2.4 per cent, for conventional theory of 31.6 per cent. Conventional theory gives too low a stress, a dangerous condition.

At the center of the outside edge there are 2½ fringes, giving a stress of $2.5 \times 86/b = -215/b$. By elastic theory it is computed as $-199/b$, and by conventional theory as $-302/b$. The errors indicated are, for the photoelastic analysis 8 per cent, and for conventional theory 52 per cent. The error in the photoelastic analysis is here very low when the low fringe value is considered. The error is actually only .2 of a fringe.

This discussion demonstrates how elastic theory may be used to supplement the photoelastic method; and shows further the accuracy commercially feasible. It is, of course, not necessary to carry through the quantitative analysis mathematically. Elastic theory should be used simply to show the trend, that is, the qualitative picture rather than the quantitative.

Contact Stress Is Important

Contact stress is the most important item to be obtained from elastic theory, beyond that already discussed. It is strongly urged that a good elementary work on this subject be studied. The condition of contact stress under a partially distributed load, under a mathematically concentrated load, and the distribution of the pressure over the contact areas of *actual* concentrated loads as given by the Hertz theories, and demonstrated by rollers on plates or other rollers, etc., should be carefully studied. They will prove of assistance in analyzing a picture.

Fig. 19 will also give a quantitative idea of Saint Venant's theory. It should be noted, for example, at how short a distance from the load the fringes assume substantially the pattern to be expected at extreme distances away. Note, also, how close the stress at the bottom of the beam under the load is to that computed without regard to the disturbance of the load itself. In *Fig.* 22 is shown a redesigned jaw. The stress pattern clearly shows how metal could be removed and change in stress pattern therefrom.

Photoelastic stress analysis as so far described is made by applying, to a scale model of the part to be analyzed, a load system that is proportional to the system actually applied to that part; and then, by a combination of optical and mathematical means, determining the edge stresses in the model. This has been discussed in detail in the foregoing. It now remains to determine from this the stress existing in the actual part, which part may differ from the model in its elastic constants and in the perfection of its approach to the ideals of theoretical analysis.

This transfer may be made in two steps, first by changing to a model of the same dimensions and loads as the actual, and second by changing the material to the actual. The first step in the transfer may be made in three stages, first by correcting for thickness, second for scale, and third for loads. The model need be to scale only as regards its dimensions in the plane of stress. The thickness may be any convenient figure. As demonstrated in Equations 19, 22, 23, and 24, the fringe order is independent of the thickness for a given load. This is because the stress changes in inverse proportion, whereas the optical effect for a given stress varies in direct proportion, to the thickness; the two effects cancelling each other. In making the model analysis therefore, the model may be assumed as 1-inch thick. By dividing by the thickness of the actual part, then, the stress in a model of the correct thickness is obtained.

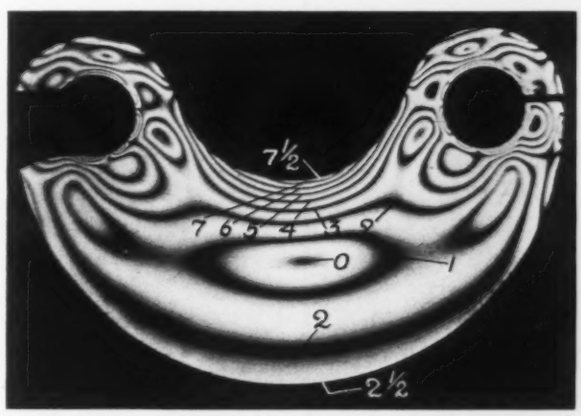


Fig. 21—Curved link under tension

Correcting for scale is the next stage. This correction is based upon the fact that, for plane stress distribution, if the two lateral dimensions and the loads are all in exactly the same proportion, scale model to full size, the stresses at similar points are identical. Note that this is based on the *same* thickness in model and full size. From this it may be seen that, if the loads are multiplied by the reciprocal of the model

scale, the stress remains the same when the model is changed to the original size.

Load correction is the third stage. Since, below the elastic limit, the stresses are proportional to the load, multiplying the stress by the ratio of the loads on the actual part to the load corrected as given in stage two, will give the stresses in a full size model with the actual loads.

Conditions Affecting Stress Distribution

The above process will be illustrated by making an example of the beam of *Fig.* 19. Assuming the actual beam is 1¼ inches thick and the model scale is 10—that is, the original is 2.84 inches deep by 28.65 inches span—the actual load may be assumed to be 4000 pounds. From the previous section the stress in a model 1-inch thick, at the bottom under the load, was found by the photoelastic analysis to be + 1462 pounds per square inch. The stress then, in a model 1¼ inches thick, would be $+1462/1.25=+1170$.

Applied load was 29 pounds, but if model were ten times as big it would require a load of $29\times10=290$ pounds to develop this same stress. With a load of 4000 pounds the stress in the enlarged model would be $(4000/290)\times1170=+16{,}130$. From this it is apparent that, if a part is the same as the original in all respects, the same lateral and thickness dimensions, and carrying the same loads in the same position, but made of model material instead of the material it is proposed to use, the stress at the bottom under the load would be 16,130 pounds per square inch tension. (We assume, of course, for the sake of this discussion, that the model material has an infinite elastic limit). It should be noted that the load, in this case, must be applied over a width of $.070\times10=.7$-inch in the actual part. However, as noted in the preceding section, at this distance away from the load the stress is only increased by 1.3 per cent by considering it as concentrated. This brings out the point previously mentioned, that usually the exact method of applying the load need not be reproduced.

Fig. 22—Stress pattern of jaw shows how redesign would save weight

It remains now only to change to the proper material. The stress distribution in a body is independent of the nature of the material of which it is made, i. e., the elastic constants are not involved in the stress distribution, provided that,

(1) the loadings and application of the loads are independent of the deformation, i.e. statically determinate
(2) the part analyzed is not a "multiply connected body"
(3) body forces are non-existent, or constant, and
(4) the elastic limit is not exceeded in either model or original.

In the beam example just cited the first three of these conditions have been met and therefore the stress is 16,130 pounds per square inch regardless of the material used, provided the fourth condition is met, that is, the material used has an elastic limit higher than the highest stress developed, which in this case is —22,600 pounds per square inch (by conversion from the figure of —2048 computed in Equation 27), immediately under the load.

If the new material has the same elastic constants as the model material the first three provisions of the second step need not be met. Otherwise the following discussion is in order.

ITEM 1: Statically indeterminate loadings require special consideration in each case. If the redundant reactions are previously determined and these quantities are applied, the problem is converted to a statically determinate one, satisfying the requirements for the transfer. If however, dependence is placed upon the elastic qualities to determine the reactions, these would be erroneous where the elastic constants of the model material differs from the original. For example, a continuous beam with supports on different levels, or on elastic supports, would have reactions that would depend upon the elastic modulus of the material in the beam. The same is true of redundant frameworks. While methods have been developed for handling these problems such cases are rarely the problem of the machine designer, but rather of the structural engineer, and their discussion therefore is not in the province of this discussion.

Likewise, if the load on the actual part is set up by producing a definite deformation, the force developed would be a function of the elastic constants, and therefore the model could not be loaded in this way. It would be necessary to know the actual load and apply it to the model.

Similarly, the reaction must not be so arranged as to produce unintended components. A beam on knife edges could easily produce a horizontal thrust that would seriously affect the stress. If these reactions are to be vertical, restraint should be placed at one end only, the other being made free by carrying on a roller, a flexible wire, etc.

In the case of contact stress, such as produced by rollers, etc., the area of contact and the pressure dis-

(*Continued on Page* 72)

How Microfilm Saves Filing Space

By S. Roth

Chief Draftsman, Detroit Edison Co.

Fig. 1—Projecting desk for viewing full size images of drawings recorded on 35-millimeter film, 700 drawings to the 100-foot length of film. Light is operated by means of treadle, and the crank at operator's right advances or rewinds the film

ROUGHLY 1000 square feet of floor space has been released for other purposes in the engineering department of the Detroit Edison Co., through use of the Microfile system of photographing drawings in miniature. Into a cabinet the size of an ordinary office file have been compressed 100,000 full size drawings, most of them 30 by 42 inches, and 270,000 bill-of-material sheets, 8 by 11 inches. Concurrently, insurance costs have become negligible, since the films on file are duplicates made from a master negative retained in the safety vaults of the company.

When the problem of accommodating the vast amount of material in the company's drafting room first became acute, an investigation was made and photography seemed to offer help for the situation. Experiments with various films were unsuccessful, however. Prints could be reduced to about 4 by 5 inches, but the process took too much time because each drawing was handled separately as a copying job. Attempts to enlarge from the negative were unsatisfactory because of its relatively coarse grain.

Newer fine grain films promised more success, so in co-operation with representatives of the Recordak Corp. and its parent company, Eastman Kodak, the problem was tackled again.

First consideration was the practical limit of reduction on drawings. Experiment established this at about 24 to 1, fitting well on 35-millimeter film. Production methods were devised for photographing an average of 1400 drawings per day, with a peak record of 2800. The camera is attached to a vertical post, facing downward, and holds 100-foot reels capable of 700 exposures. Lights are adjusted to give about 50 foot-candles of illumination on the drawings. An inverted light meter is mounted beside the work to determine the light reflected from the drawing, *Fig.* 2.

The next problem was how to use the miniature negatives conveniently to obtain a full size image for reference, or to make a workable size print in short

(*Concluded on Page* 104)

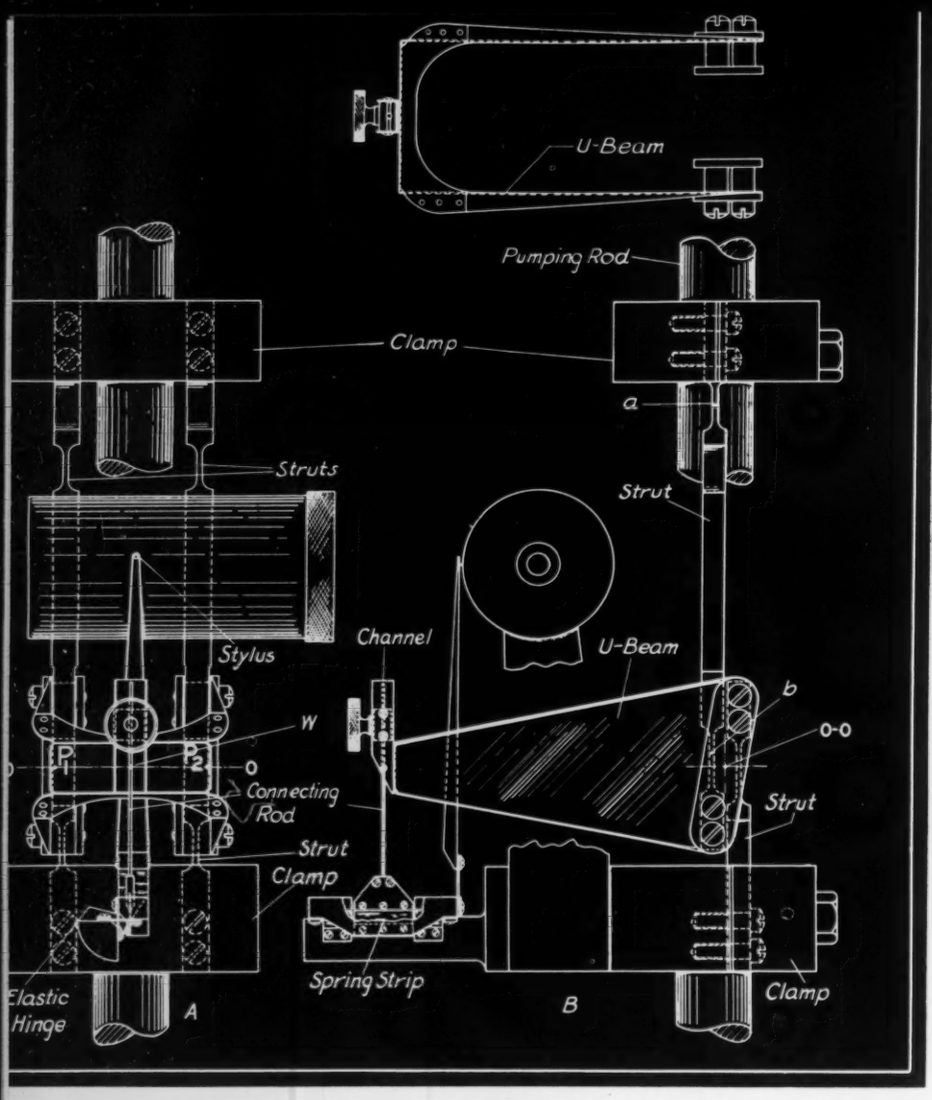
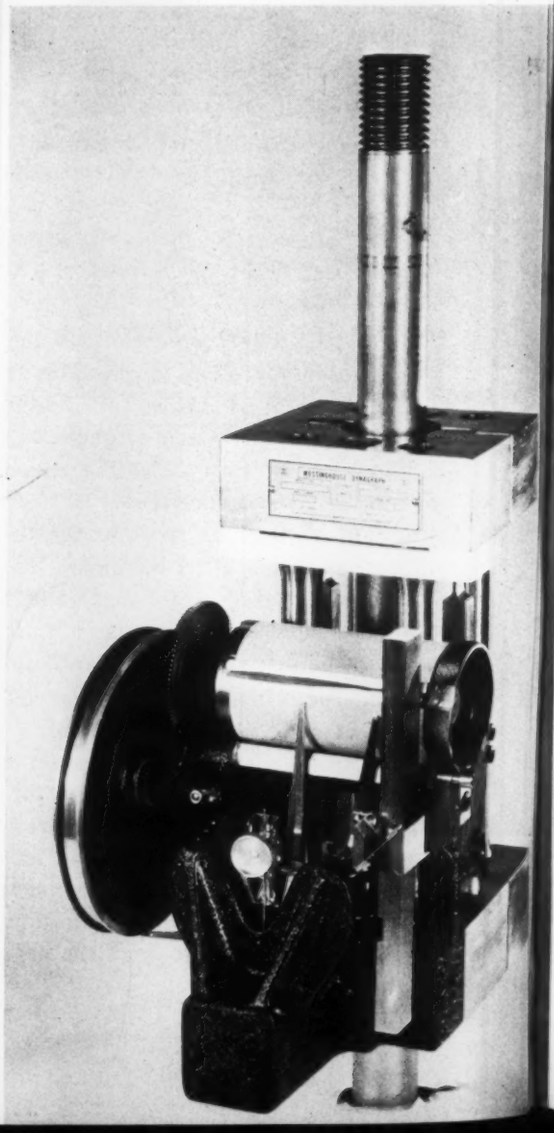


Fig. 1—No wear or lost motion are encountered in this design employing elastic members. Drive for recording drum is obtained from a stationary part

Fig. 2—Stresses are measured and recorded on drum. Spring-mounted bar serves as timer to measure velocity and acceleration



Elastic Members Insure Accuracy

By H. C. Werner

ELASTIC members rather than pivots or pins are utilized for mounting all moving parts in the unique strain gage illustrated in *Figs.* 1 and 2. This provision eliminates lost motion, wear and friction in the mountings and insures a high degree of accuracy even after extensive use. Designed for measuring the stress in oil well pumping rods, this Westinghouse instrument obtains the instantaneous load over a pumping cycle, instantaneous velocity and acceleration of the rod and the power required for pumping.

Measuring the strain in a loaded member of the instrument to obtain the load on the rod is the simple principle of operation, and

because of the large amount of energy available compared with that required for the operation of a recording stylus no external source of power is required to produce a record.

Referring to *Fig.* 1, two clamp assemblies are mounted on the pumping rod. Load increases result in a stretch in the pumping rod between these clamps causing the struts to produce a rotation of the U-beam about a horizontal axis. This rotation gives a vertical movement to the channel which is some ten times the extension between clamps. Channel is attached by a connecting rod and through an elastic point to the recording stylus which moves horizontally some forty times the vertical movement of the channel. The displacement of the stylus is then some four hundred times the original extension.

Wound around the pulley, *Fig.* 2, a string is held against some stationary point. Movement of the pumping rod up and down rotates the pulley and also a recording cylinder by means of gears. The timer is a bar, *Fig.* 2, spring mounted on the frame of the instrument and actuated by pushing the lower end over to a stop and then releasing. It vibrates long enough to make a timing wave for a complete cycle of the pump. The velocity and acceleration of the pumping rod can be obtained from measurements of this timing wave.

Various sizes of rods are accommodated by means of inserts placed into the main clamping members. *Fig.* 3 shows the detail of the construction for the lower clamp. The clamping insert functions to define the elevation of the instrument with respect to the pumping rod. A double conical groove, in which the insert fits, prevents any relative motion between the insert and clamp. The function of the upper insert fitting into the diaphragm is that of aligning the instrument axis with that of the pumping rod. This diaphragm allows flexibility between inserts and avoids possible slipping due to normal stretching of the portion of the rod between the inserts. The upper clamp contains only a clamping insert, the diaphragm or aligning insert being omitted.

Condition for Zero Bending Error

It sometimes happens that there is insufficient clearance between the lowest position of the cross arm and the stuffing box of a well for mounting an instrument. In other cases the pumping rod is badly worn so that its cross-sectional area is uncertain. In still other cases the modulus of elasticity of the rod is unknown. If any of these conditions exist and if there is room above the pump cross arm, the instrument may be used in such a way that the total well load is taken through auxiliary columns, *Fig.* 2. The deflection of these columns is a measure of the load. For this purpose the total load is applied through the clamps.

By proper location of the necked-down portions of the struts and of the clamping points of the springs in the elastic hinge, not only is a straight line calibration curve obtained but the error due to incidental bending of the pumping rod is almost reduced to zero.

Bending of the pumping rod in the plane of *Fig.* 1*A*, causing rotation of the upper clamp clockwise, lowers the point P_2 and raises the point P_1 an equal amount. Thus the elevation of W does not change, the stylus does not move and therefore no error results. Bending of the pumping rod in the plane of *Fig.* 1*B*, causing rotation of the clamp clockwise, bends the necked portions of the struts at the points a and at the elevation O-O but does not rotate the U-beam with respect to the lower clamp, hence there is no motion and no error. For a large amount of bending of the rod, the lateral position of the struts and axial positions of the necked-down portions of the struts and the axial position of clamping the connecting rod are important. Tests on the instrument indicate that the bending error is less than one per cent of the full scale deflection for bending stress as high as 15,000 pounds per square inch on a 1¼-inch rod.

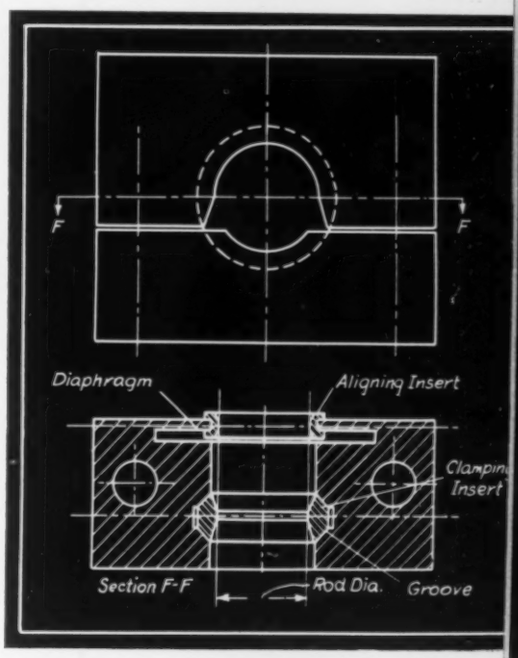
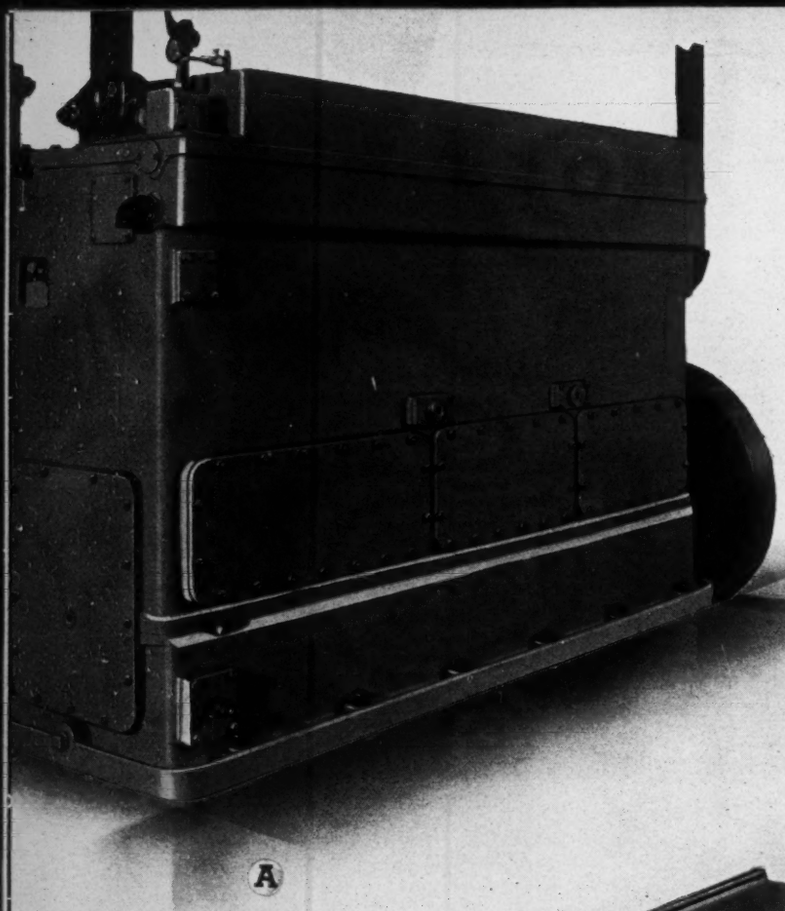


Fig. 3—Clamp construction aligns instrument. Diaphragm allows flexibility and prevents slippage

In case the well load is accidentally placed on the instrument when it is mounted on the pumping rod below the cross arm, the clamps will slide toward each other until the clearance between the four columns, *Fig.* 2, and the clamp is taken up. This motion of the clamp results in more than ¼-inch movement downward of the point W, *Fig.* 1*A*. The recording stylus normally allows a movement of W less than 1/10-inch per full scale deflection. Extra deflection under accidental loading is taken by the buckling of the connecting rod and the breaking of a small spring strip. The diameter of the rod is chosen small enough so that no damage to the stylus mechanism results.



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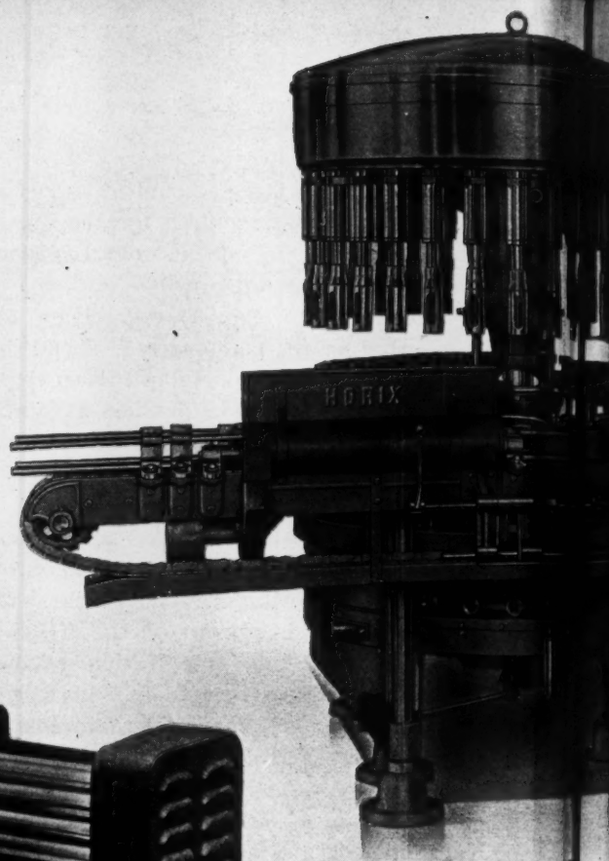

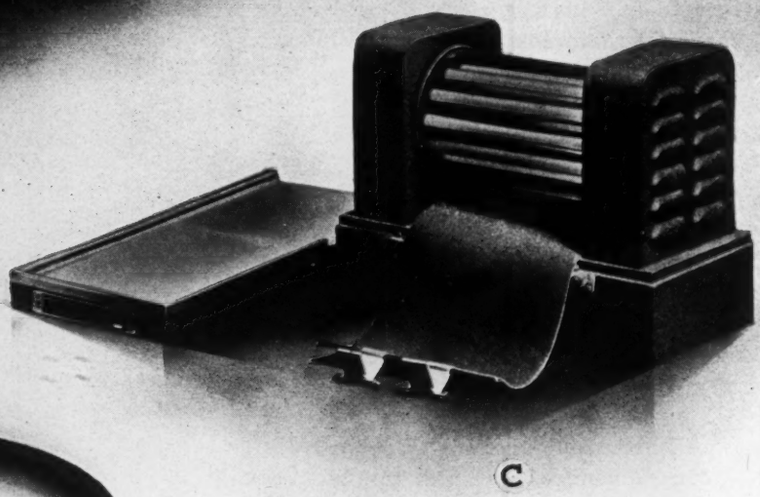

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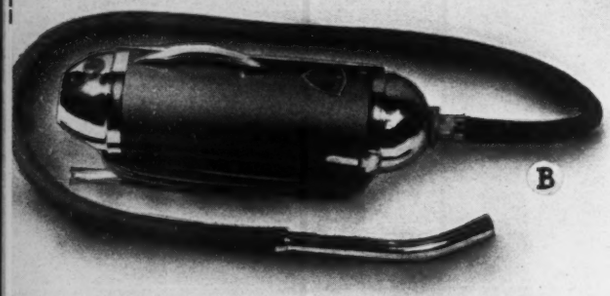

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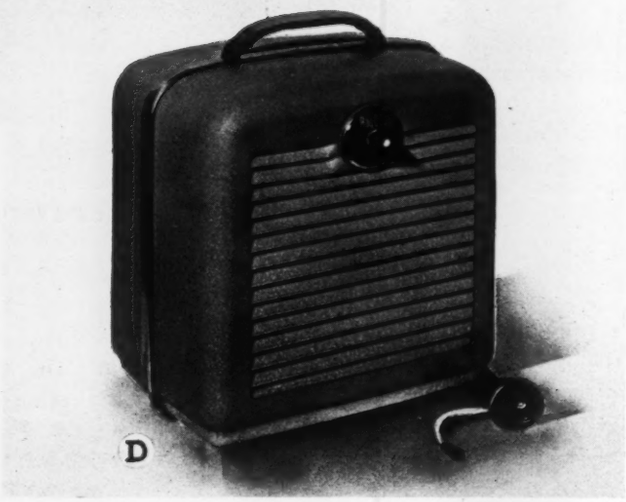

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THIS MONTH'S CO

corrosive metal, the T Fre
ends of cast aluminum e fre
and draw-off gate are m meta
third-horsepower comp is s
cooled. Air intake and st a
nating grilles ther

No water jackets are used in cooling the Bruce-Macbeth gas engine (A) but all parts requiring cooling are submerged yet visible and accessible. Water is introduced into a tank and overflows through pipes which maintain proper level, providing constant circulation. Solid one-piece castings are used for lower crankcase and upper crankcase and cooling tank. Throttling type mixing valve automatically maintains correct gas and air

Household electric c en
violet tubes in the Zone
machine (D), this acti eatin
which discharges lar antit
destroying impurities, an
housing is sixteen-gag nped
steel is used for trim r co
of the cabinet. Louves t and
openings through wh e o
circulation by a chr plat

Filter plug attached to frame holding motor assembly of Westinghouse Pacemaker vacuum cleaner (B) acts as a radio interference eliminator. Welded steel shell is completely insulated from the motor-holding frame and fan assembly by rubber, eliminating vibration. Two six-blade turbine type fans create powerful suction and are separated from each other by a stationary baffle plate. Inside of shell is painted to prevent rust, outer shell has gray bake-on finish with hammered effect

Chief element of the Dick photochemical printer (C) is a new type of brilliant "cold" light, evenly distributed through tubing surrounded by a transparent plastic cylinder. By exposure to this light, any opaque drawing on translucent cloth or paper can be transferred to a sensitized stencil sheet. At left is electrically heated, bright stainless steel developing plate. Portable, the unit has a durable cover finished in wrinkle

Highest speed liquid ilt,
quarts per minute, the rotar
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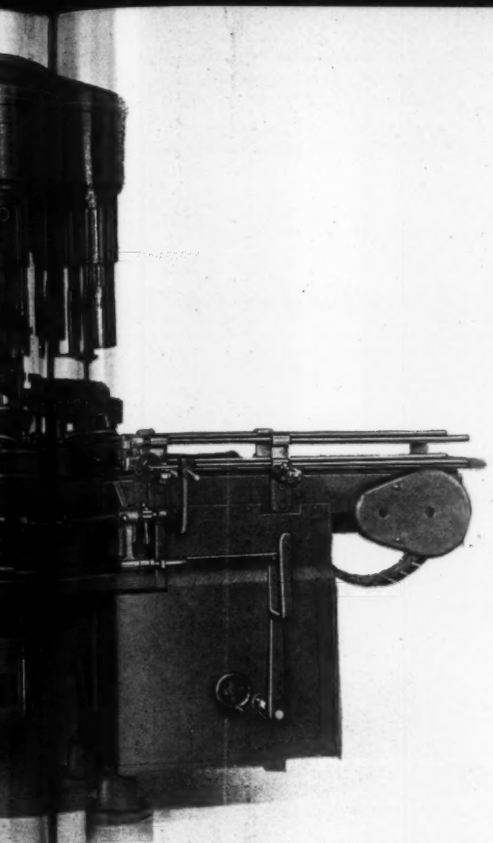

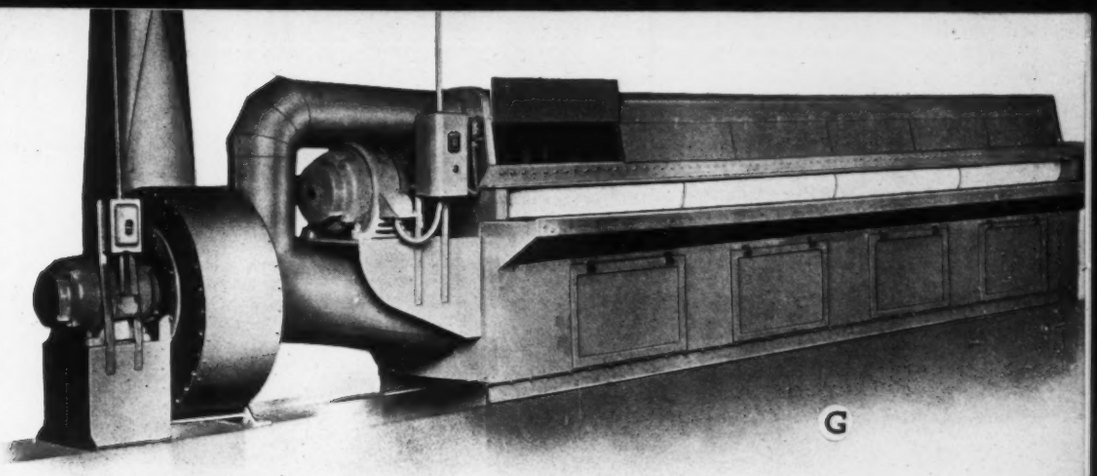

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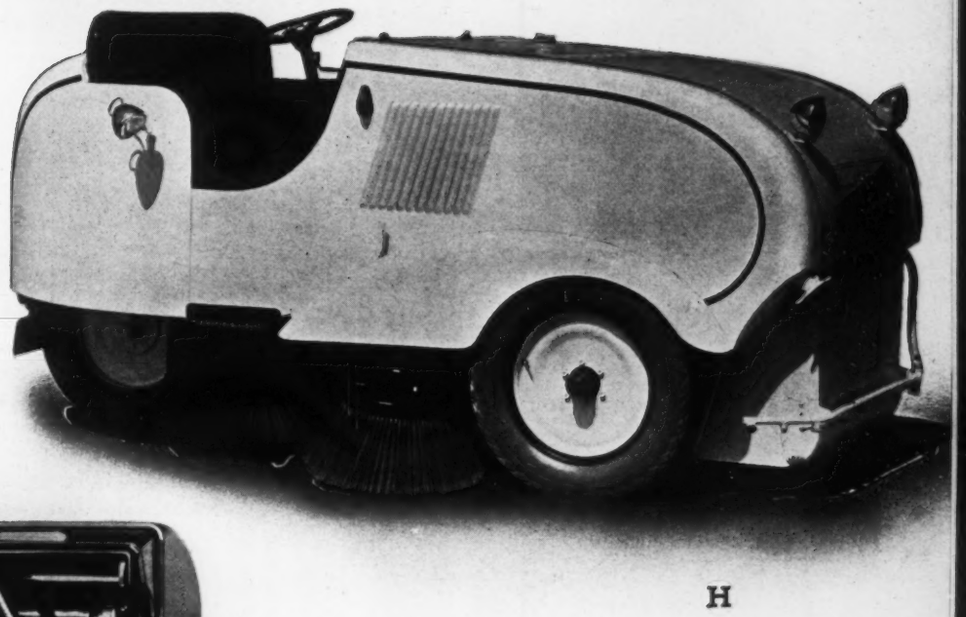

H

...sig... Features ... MACHINES

...new ...e listing see page 124)

...S CO...R. Built entirely of non-...the T... Freezette has base and ...inum... freezer cylinder, dasher ...are d... metal and monel. Its one-...compr... is self-contained and air-...and d...st are through base elimi-...illes ...her dirt catchers

...ic c... energizes three ultra-...the F... Zone oxygen generating ...s actu...eating a halo or corona ...s lar...antities of free oxygen, ...ities, ... and fumes. Two-piece ...n-gag...ped steel, and stainless ...trim ...r concealing joining line ...ouves...t and back furnish ample ...whi...e oxygen is forced into ...chr... plated motor-driven fan

F

...uid ...uilt, with capacity of 150 ..., the ...rotary filling machine (E) ...wi... number of filling valves ...mor... unusual screw feed, syn-...e in...ret, accurately places the ...the ...while a similar turret re-...conta... the discharge side. A ...-vacu...ng principle, eliminating ...e a...venting filling defective ...Fillin... and tank are accessible

After research showed it harmonized well with colors in any office, automobile lacquer finish of warm gray was used on the Ediphone (F). Upper part contains the operating unit, where light weight is attained with aluminum wherever possible, while a letter compartment and space for eight wax cylinders and correspondence folders is provided in lower part. A flashing light in a molded plastic receiver, warns user if operating lever is in wrong position

Rug feeds in at front and is delivered at rear of Connersville Acme rug beater (G), feeding being accomplished by traveling wood bed with springs above, placed about three inches apart to hold the rug against friction of the leather straps. Beater shaft and brushes are driven by a direct connected motor. Base of I-beam construction gives equal distribution of weight, with metal flooring on top flange of I-beams to give dust-tight chamber

Mounted amidships, a four-cylinder, 31-horsepower gasoline engine powers the South Bend Gutter Snipe (H), fitted with a standard automotive transmission and reductions for vehicle travel. Pickup broom is chain-driven and is supported in self-aligning bearings permitting sweeping on uneven or crowned pavements, pressure on the pavement being adjustable. Operations of the hopper, gutter broom and pickup broom are controlled hydraulically. Hopper is corrosion-resistant steel

MACHINE DESIGN

Editorial

Planning for Eventualities

FIFTY thousand planes! All agree such a defense measure is imperative. Development and dsign, however, as well as production must keep pace with this pretentious program. Much development cost has already been carried by those planes sold abroad. Continued research can thus be better borne now to develop planes of advanced dsigns.

Whether the war stops soon or continues, industry in general should become so organized within itself for better production methods. And now is the time for all engineering departments to put into effect long-considered plans for efficient reorganization.

Pressure during war to supply war materials or equipment for making them will grow increasingly. Furthermore, the competition after the war will be severe because of goods dumped on the markets from highly organized nations manufacturing with modern equipment.

With respect to this latter eventuality, a large percentage of our machine tools are now being sold abroad. These machines are not single-purpose but rather are general purpose units applicable to peace-time production. "War babies"—they will compete with equipment here, much of which is twenty years obsolete.

But design is dynamic. Those machines now being delivered to foreign markets are not only bringing trade to this country but are paving the way for the design of better, more advanced machines with which to equip our plants.

Widespread fear of equipping foreign nations to better compete for trade brings to mind a recent statement of a well known executive who said, "By the time competition catches up to our company's present methods we will be so far ahead that they still will be using obsolete methods." In this same way industry in general will have to view production in foreign countries for world trade, keeping our place by being always in the lead. Whatever the eventualities we must be prepared to meet them.

Silver Alloy Brazing Effects Design Economies*

By Robert H. Leach

Vice President
Handy and Harman

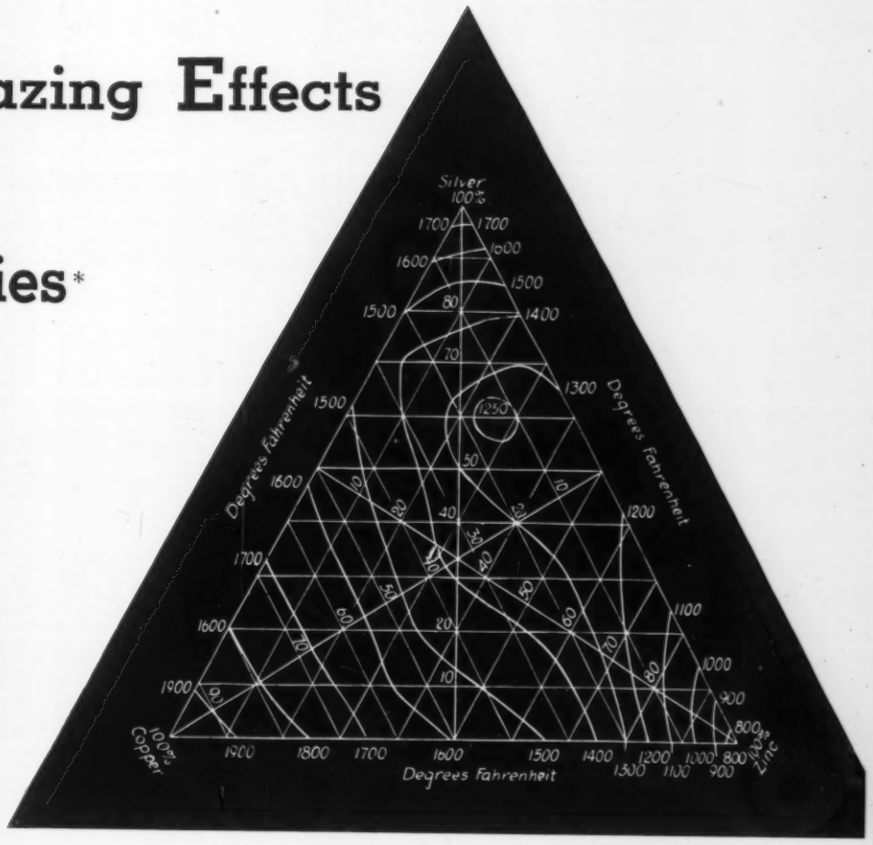

Fig. 1—Ternary diagram of flow points of silver, copper and zinc alloys

ALTHOUGH the quantities used of silver brazing alloys are smaller in comparison with base metal brazing alloys, the amount of joining with silver alloys is impressive. Best results are obtained when the joints are closely fitted, requiring a much smaller quantity of the alloy to be used than is the case with the V-joints or heavy filleted joints which are common to base metal brazing or soldering.

Silver brazing alloys are especially useful for making joints where strength and resistance to shock are required such as joining band saws, shrouds and lacing wire for turbine blades, and in the fabrication of equipment where appearance as well as strength is important. A. S. T. M. specifications for these alloys are given in the following table. Impurities do not exceed .15 per cent in any grade.

These eight grades were selected after tests to determine the range of compositions required to meet different industrial requirements. The ternary diagram of the flow points of silver, copper and zinc alloys is shown in *Fig.* 1. It is evident from a study of the diagram that without some attempt at standardization, there would be a tendency for the production of a large number of different compositions with no material benefit.

As might be expected, increasing use of the standard alloys encouraged extensive research and the development of other silver alloys for brazing. There was a demand for alloys with even lower melting points without sacrificing the strength or the free flowing properties of the standard alloys. Moreover, there are certain corrosive conditions where the presence of zinc might be harmful, and in other cases copper might be undesirable. The result has been that there are available now silver brazing alloys, in which other metals, such as cadmium, manganese, tin, nickel and phosphorus are used to give special properties.

Any article dealing with the development of silver alloy brazing would not be complete without mention of the characteristics of some of these special alloys. The silver copper eutectic which contains 72 per cent silver and 28 per cent copper melts at 1435 degrees Fahr. and is used when zinc in the alloy would give trouble. Alloys containing silver, copper, manganese and those with a further addition of nickel and silicon are used for similar purposes. Zinc or zinc and cadmium combined with relatively high percentages of silver provide a series of alloys that melt at temperatures between 1300 degrees and 1400 degrees Fahr., have a white color and are used for those conditions where copper would be objectionable. An alloy containing silver, copper, zinc and cadmium which flows freely at 1175 degrees Fahr. is used extensively for joining both ferrous and nonferrous metals and alloys, because it flows freely at this temperature and makes

* *From a paper presented at the annual convention of International Acetylene Assn.*

Standard Alloys Specifications

Grade No.	Silver %	Copper %	Zinc %	Cadmium %	Melt. Point °F.	Flow Point °F.
1.....	10	52	38	‡	1510	1600
2.....	20	45	35	‡	1430	1500
3.....	20	45	30	5	1430	1500
4.....	45	30	25	nil	1250	1370
5.....	50	34	16	nil	1280	1425
6.....	65	20	15	nil	1280	1325
7.....	70	20	10	nil	1335	1390
8.....	80	16	4	nil	1360	1460

‡ *The addition not to exceed .5 per cent of cadmium to assist in fabricating shall not be considered as a harmful impurity.*

strong joints. Another contains silver, copper and phosphorous and flows freely at 1300 degrees Fahr. Phosphorus makes the alloy self fluxing to a considerable degree and is used with copper and copper base alloys. It is not recommended for steel or iron because of the brittle phosphide of iron that is produced in the joint.

There is no definite rule to follow in selecting the grade of silver brazing alloy as several different factors have to be considered, among which are: Metals to be joined, corrosion conditions, type of joint and stresses that may be applied.

As far as melting point is concerned a silver-copper-zinc alloy containing 10 per cent silver does not have any material advantage over the common brazing or spelter alloys, but it contains about 12 per cent less zinc and as it is malleable and ductile, it can be rolled into thin strips and drawn into fine wire. It is sometimes used when quenching at temperatures about 1300 degrees is done after joining, and with copper and copper base alloys when first cost seems to be the

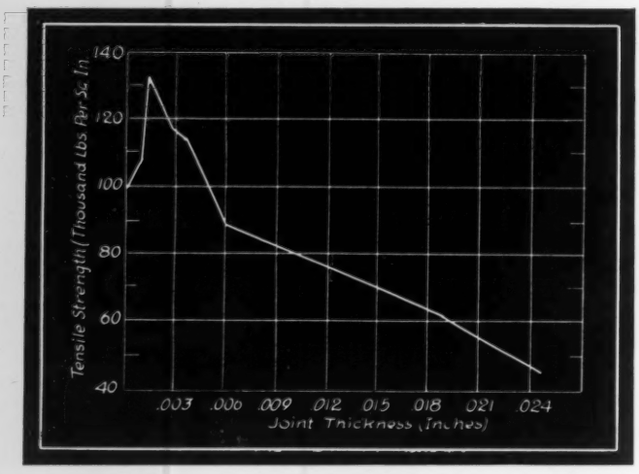

Fig. 2—Relation of joint thickness to tensile strength based upon butt joints of stainless steel to stainless steel

controlling factor, and it is felt that the heating will not cause excessive grain growth or other damage.

The 20 per cent silver alloy in this group is used on copper and copper-base alloys, also on steel and dissimilar metals. It has a yellow color and as it flows freely at 1500 degrees Fahr. it can be used for brazing extruded bronze when reasonable care is taken in heating the joint.

With 30 per cent silver and above more benefit from the low melting temperatures is obtained due to the silver content and a lower percentage of zinc can be used. Those alloys containing from 40 to 50 per cent silver and from 25 to 16 per cent zinc are probably the most widely used of the silver-copper-zinc group. They are used on ferrous and nonferrous metals and alloys, and melt at temperatures around 1400 degrees depending upon the composition.

Silver brazing alloys have a higher electrical conductivity than base metal brazing alloys and their use is therefore particularly desirable for parts of electrical apparatus where conductivity is required. Zinc tends to lower conductivity and the silver copper eutectic previously mentioned has about 70 per cent of the conductivity of copper.

Any of the standard silver brazing alloys are resistant to most of the common types of corrosion. When unusual conditions are met it is desirable to make up specimens and subject them to the actual conditions of use to determine the best alloy. Galvanic corrosion is a problem but as it is generally in proportion to the areas exposed to attack, a cathodic joining alloy would give the best result. Silver alloys with high percentages of silver are cathodic to many metals and alloys used to resist corrosive conditions and are therefore satisfactory under such conditions. For example, these high grade silver alloys are cathodic to monel metal and stainless steel under many corrosive conditions for which these metals are used. They should not be used, however, for joining stainless steel when the joints are likely to be attacked by nitric acid.

The question of color match with different metals and alloys is often raised. Those silver brazing alloys with low percentages of silver are yellow and the color becomes whiter as the silver is increased. Alloys without any copper and high silver are the whitest, but the band of brazing alloy which is visible in a properly fitted joint is so narrow that any slight difference in color is generally a negligible factor.

Question of Form Important

Having selected the grade of alloy, the question of the form that is best suited for any particular application is important. The malleability and ductility of silver brazing alloys allow them to be produced in any form that will be convenient and also economical to use.

There is a rapidly growing use of inserts of these alloys. By preplacing them before heating the following advantages are obtained: Control of the amount of alloy used, thus eliminating waste, better assurance that the alloy will be properly distributed over the joint surfaces, and assemblies having a large number of joints can be made up and heated at the same time.

When tubular members are joined pressure cannot be applied and there is nothing to break down the surface tension of the molten alloy and cause it to flow except gravity and capillary action. It is in joints of this type that the joint surfaces must be given particular attention in order that the molten alloy will wet them and spread evenly.

Joints made with silver brazing alloys on both similar and dissimilar metals for boiler construction have been subjected to extreme tests entirely beyond anything to be expected in use and no signs of failure occurred in the brazed joint. One example is a steam

(*Concluded on Page* 116)

Professional Viewpoints

". . . efficiency should not be burdened"

To the Editor:

May I comment upon Senator O'Mahoney's letter in your May issue?

Undoubtedly improved methods and machines, particularly labor-saving machines, frequently throw men out of work. In other walks of life, also, change results in dislocations, and, as every business and professional man knows, if someone comes along with a better way of doing what he is occupied with he may lose his business or his practice. The only remedy is either to keep up with, or to lead, the procession.

Perhaps this is more than should be expected from some factory workers, but the proper remedy is not to lay on more taxes (which seems always to be the first thing that the politician thinks of), but to undertake constructive measures to aid the men in transferring to other employments, either by moving to a new locality or by acquiring new skills.

Improvement and efficiency should not be burdened by a punitive tax, as that takes away the incentive to progress and hurts all of us.

—Luis Gibson
Geo. H. Gibson Co.

". . . use honest and frank forms"

To the Editor:

There is no doubt that the appearance of most machines has improved over the last ten years. For the most part they are enclosed, compact and efficient and are better in color treatment and decorative effects. Enclosing forms carry to the floor or sub-base thereby imparting greater stability and better unity. Legs and crude proportioned supports succumb to housing covers. Isolated wheels, parts or sections are correlated to the mother machine by identical or similar covers or colors. Curves are popular here as elsewhere in the design field.

"Streamlining" creeps in when all else fails to enliven or modernize the product. Improvements and new facilities in shaping metals have helped toward this end. Part of this development is due to impetus of safety features, to the need of enclosing dangerous moving parts.

Use of color today, is partly due to the painting of exposed parts to prevent accidents—red here and there in spots calls for other colors to go with red—or again—to the use of eye-restful colors to maintain or speed up efficiency. Elimination of exposed bolts, screws, or flanges on the exterior through the use of moldings or hidden devices etc. improves appearance. Decorative moldings of chrome-plated or nickel finished metal contrast nicely with the gray wrinkle finish often used on housing units.

I feel that curves and streamlining are being overdone. The fallacy of curves is that they are apt to weaken and make effeminate an otherwise strong masculine-looking machine. A machine should retain inherent functional characteristics of its construction.

Certain continental machinery-design retains definite machine features and appearance. They look like what they are designed to do. We tend to cover up machine beauty with skirts or dresses to make them appear what they are not. Mechanical design and engineering is one of great strength and beauty. As abstract design it is thrilling and functionally perfect. To cover it indiscriminately without any thought as to the form or character underneath is to shut away some of that beauty. Honest and frank rectilinear forms are not hideous.

—S. G. Warner
Ann Arbor, Mich.

". . . articles studied with interest"

To the Editor:

Some of your published articles pertaining to springs of various types and factors affecting them have been studied with interest, and there are no doubt several articles which have not come to my attention. I would therefore appreciate knowing what articles and bibliography you may have published and if I may obtain a copy of all of them.

We have many spring design problems in our machines, of both the coil and flat springs, and I'm sure you may have some publications which may be of direct aid in our designing.

—H. L. Tholstrup
International Business Machines Corp.

Men of Machines

D. E. WYMAN

DEVOTING more than twenty-five years to the industrial heat treating, furnace and combustion field. D. E. Wyman has assumed the position of vice president in charge of engineering of R-S Products Corp. His experience has included that of designing industrial heating equipment, particularly for the metal industry, and he is credited with many innovations and advanced designs for industrial furnaces. Beginning his career in this field, Mr. Wyman joined Mircs Fuel Oil & Equipment Co., and filled the positions of chief draftsman and chief engineer until the company's subsequent merger with Ryan-Scully & Co. He then became affiliated with Philadelphia Drying Machinery Co. as chief engineer of the industrial furnace division, and served in this capacity until his present appointment with R-S Products Corp., which organization has taken over the business of Ryan-Scully & Co.

C. J. MARTIN

WIDE experience in designing and building high production precision machine tools, special machines and equipment, along with resistance welding equipment, is the background of Charles J. Martin, new chief engineer of The Federal Machine & Welder Co., Warren, O.

A graduate mechanical engineer, Mr. Martin became a practical mechanic by spending considerable time as a machinist and toolmaker in automobile plants. Prior to joining Federal Machine & Welder Co., he was assistant chief engineer of the Ford Motor Co., from 1923-1934. Here he had charge of the design of all production equipment including special machines, dies, gages, ovens, welding equipment and conveyors, as well as supervising plant layout. From 1934 until his present appointment Mr. Martin was affiliated with the Ex-Cell-O Corp. in the capacity of machinery salesman and sales engineer.

A. M. MACCUTCHEON

ACTIVE in the engineering field both from the standpoint of actual practice and engineering society leadership, Alexander M. MacCutcheon has recently become engineering vice president of The Reliance Electric & Engineering Co., Cleveland.

Born in the state of New York, he attended the Albany State Normal college. Before entering Columbia university, from where he received his electrical engineering degree in 1908, he taught mathematics and science in the high schools. He then was employed by Crocker-Wheeler Co. until 1914, successively in charge of engineering estimates and proposals, and the drafting room. Joining Reliance Electric he took charge of all new design work for the company. Three years later, in 1917, he was appointed chief engineer. That fall he entered the U. S. Navy and at the end of his release in 1919 he returned to his former position with Reliance. He was elected

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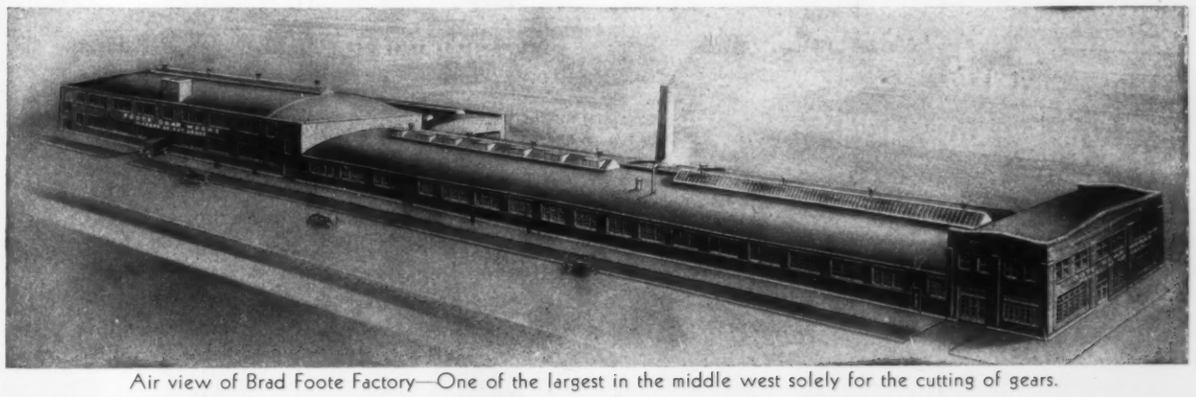

Air view of Brad Foote Factory—One of the largest in the middle west solely for the cutting of gears.

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a director of the company the following year. Mr. MacCutcheon is a past-president of The American Institute of Electrical Engineers.

♦

IVAN C. CRAWFORD, dean of the School of Engineering and Architecture, University of Kansas, has been appointed dean of the College of Engineering, University of Michigan, effective July 1. He succeeds the late Henry C. Anderson.

♦

JOHN V. O. PALM, chief engineer, has been named vice president in charge of engineering and research of Cleveland Graphite Bronze Co.

♦

R. W. SORENSEN has been nominated for the presidency of the American Institute of Electrical Engineers. He is professor of electrical engineering and head of the department of electrical engineering, California Institute of Technology, Pasadena, Calif. Those nominated for vice presidents include EVERETT S. LEE, General Electric Co., Schenectady, N. Y.; and K. L. HANSEN, Harnischfeger Corp., Milwaukee.

♦

GEORGE A. DELANEY, former electrical engineer, now heads the experimental laboratories of Pontiac Motor Division. GEORGE W. LAMPMAN, designer, has been placed on special assignment in charge of all rubber developments in recognition of the growing use of rubber in engine design. Formerly assistant to chief engineer, FORREST H. KANE has been promoted to executive engineer.

♦

WILLIAM J. BELCHER has been appointed vice president in charge of engineering, Whitney Chain & Mfg. Co.

♦

PAUL E. HOVGARD has joined The Glenn L. Martin Co., Baltimore, as chief research engineer succeeding JOHN B. WHEATLEY who now assumes responsibility for the company's development work. Mr. Hovgard is a veteran test pilot and engineer.

♦

OTTO C. VOSS, of Allis-Chalmers Mfg. Co., will receive the 1939 James Turner Morehead medal awarded by the International Acetylene association "for continuous pioneering, untiring educational effort, and constructive sponsorship of oxyacetylene process applications."

♦

A. H. D'ARCAMBAL, consulting metallurgist, Pratt & Whitney division, Niles-Bement-Pond Co., Hartford, Conn., was recently elected president of the American Society of Tool Engineers.

♦

COL. O. B. ZIMMERMAN has been awarded the Cyrus Hall McCormick gold medal for 1940 presented by the American Society of Agricultural Engineers for his methods, his spirit of pioneering and his tangible achievements in the field of agricultural engineering.

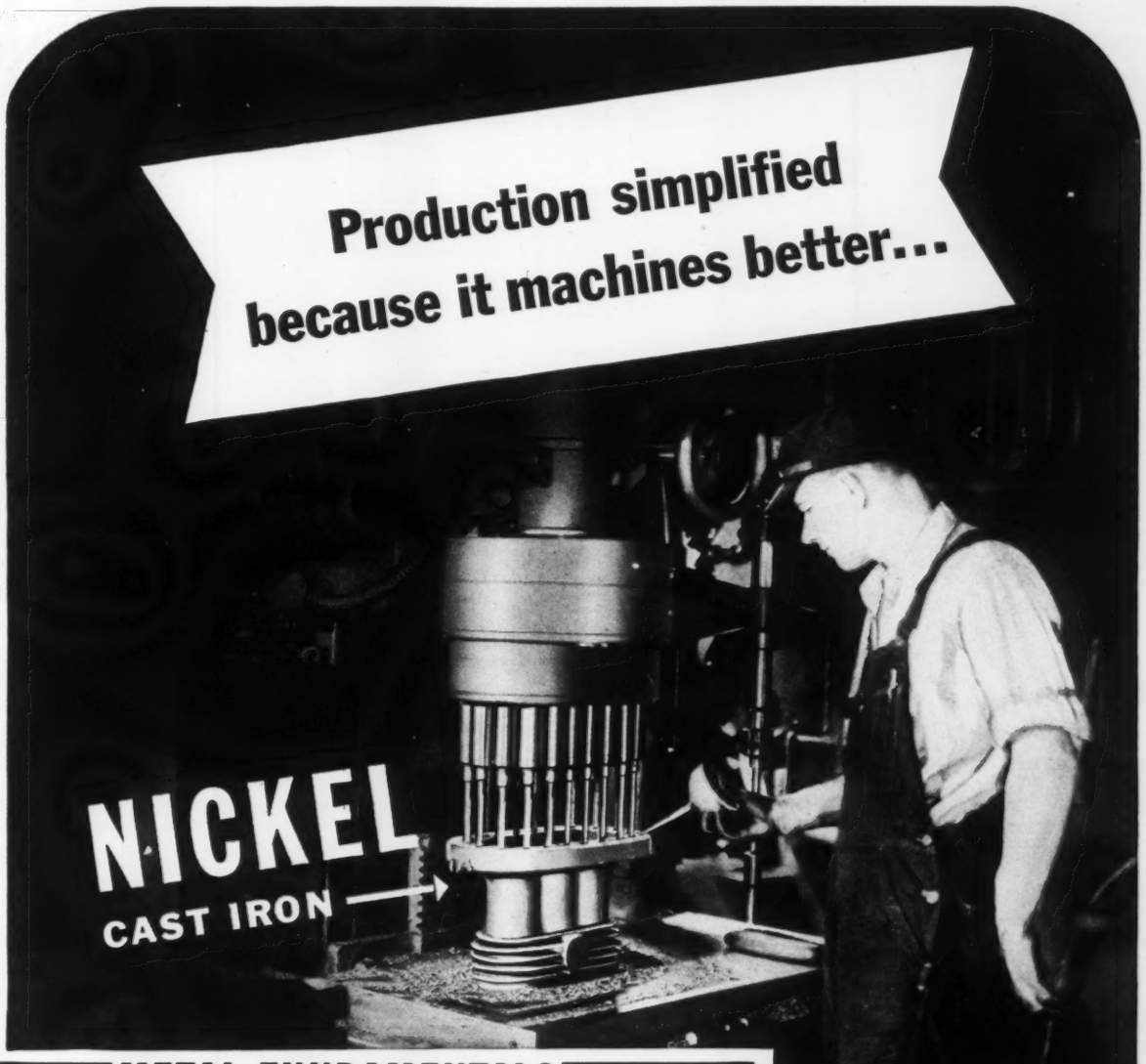

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Photo courtesy of York Ice Machinery Corp., York, Pa.

Producing cylinder blocks or other castings with sections of varying thickness, a manufacturer's first thought is machinability. From long experience, he depends upon Nickel alone or in balanced combination. He knows Nickel added to cast iron assures improved machinability and uniformity of structure, plus higher strength and wear resistance in finished parts.

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BETTER MOTORS

Photoelastic Analysis

(*Continued from Page* 58)

tribution is a function of the elastic constants. It would be necessary to determine the actual load distribution and apply it, to scale of course, to the model. However, as previously mentioned, the effect upon the stresses is highly local and at short distances away the effect would be negligible. The local stresses may easily be calculated by elastic theory.

Bakelite has only about 1/50 the rigidity of steel. Therefore, it is necessary that no "column action" occur, as the lateral deflection could easily be excessive, causing a considerable alteration in the stresses, or a departure from plane stress distribution. On the other hand, theoretically, plane stress distribution will occur only in a material infinitely thin. Too thick a material will therefore cause some departure from plane stress distribution. It will also accentuate some of the difficulties in technique, the thicker material being more difficult to anneal satisfactorily, to load concentrically, and requiring higher quality in the polariscope itself.

ITEM 2: A "multiply connected body" is one having at least two separate boundaries. A simple case would be a piece with a hole. If the resultant of all the forces applied to each one of these boundaries separately is equal to zero, the elastic constants are not involved; but, if any of these resultants differ from zero they are, and a direct transfer is not theoretically possible. A case at point is the calibration specimen of *Fig.* 15 in Part III. The stress distribution adjacent to the holes is there dependent upon the elastic constants. However, it has been demonstrated* that this error is usually very small, and it may safely be neglected in practical work, permitting a direct transfer. Inasmuch as parts will frequently have loads applied at holes, this conclusion is important.

ITEM 3: It was pointed out in Part II that body forces, where present, must be constant if the elastic constants are not to be involved in the stress distribution. In most cases body forces are absent, or are small enough so that their effect may be ignored. There are cases however, such as flywheels and other parts subjected to inertia forces, in which body forces are the main loading, and their distribution is not constant. In these cases a direct comparison between materials of different elastic constants is theoretically impossible. It is necessary to consider separately each individual case to decide whether the errors in-

* *See discussion in Timoshenko's Theory of Elasticity, Page* 117. *Also, Frocht and Hill report extensive tests on a multiply connected body in Journal of Applied Mechanics, March,* 1940. *Comparison is made between results obtained photoelastically on Bakelite with strain gage measurements on high strength aluminum alloy. It is interesting to note that although Poisson's ratio differs for these two materials, no appreciable difference in the tests were found.*

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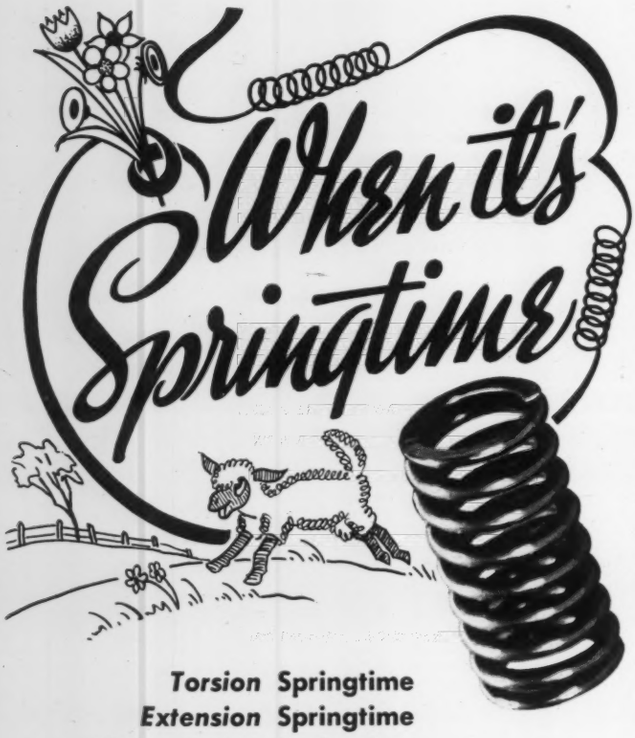

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troduced by ignoring the differences in the elastic constants are too great to permit photoelastic analysis. Bakelite BT-61-893 is reported as having a Young's modulus of about 600,000 and Poisson's ratio of approximately .35; all steels, (excepting the very high alloys such as stainless, high speed, etc., which should really not be classed as "steel"), are generally conceded as having a Young's modulus of 29,000,000 and a Poisson's ratio of .3.

The reader is also referred to the brief discussion in Part II of the imperfections of actual engineering materials. Photoelastic analysis will most frequently be used to study high "stress concentrations" where local plastic action with its accompanying stress relief is of great importance. This stress relief is almost nonexistent in photoelastic materials; so nearly perfectly elastic are they that figures almost identical with those arrived at mathematically, are obtained. Therefore some allowance must usually be made for this departure from the calculated stress. Entirely too little research has been conducted into this very important matter. What little there is would indicate that the action is very high in soft steels, is less in the heat treated alloys, and much less in the very hard tool steels. However, some steels, even though softer, will show less adjustment than the harder ones. In fact, to such an extent is this true that it is entirely possible for a steel showing a decidedly lower ultimate or fatigue strength than another to involve less risk of failure, in a particular application, than the higher strength material.

In brittle materials such as glass, plastics, etc., practically no relief at all occurs. On the other hand, stress raisers in cast iron may be almost ignored because the matrix of cast iron consists of a multitude of stress raisers that mask any produced by a boundary configuration.

It would appear that this stress relief is more pronounced the steeper the stress "gradient", and the more highly localized the stress. It also appears to occur to a greater extent in the fine grained than in coarse grained steels. There is probably, also, more relief the steadier the stress, full reversals being considerably more serious than one direction only loadings. On the other hand, the stress relief under a single impact may be quite low, particularly on the heat treated alloy steels.

As stated previously, there is entirely too little research data to warrant positive conclusions and the designer must proceed with great caution. If failure would be serious, in the absence of an experience record or of definite data on the material with the heat treatment and configuration that it is proposed to use, it is probably best to design with the full, unrelieved photoelastic or mathematical figure. Reference should be made to the available literature on this important subject.

(CONCLUDED IN NEXT ISSUE)

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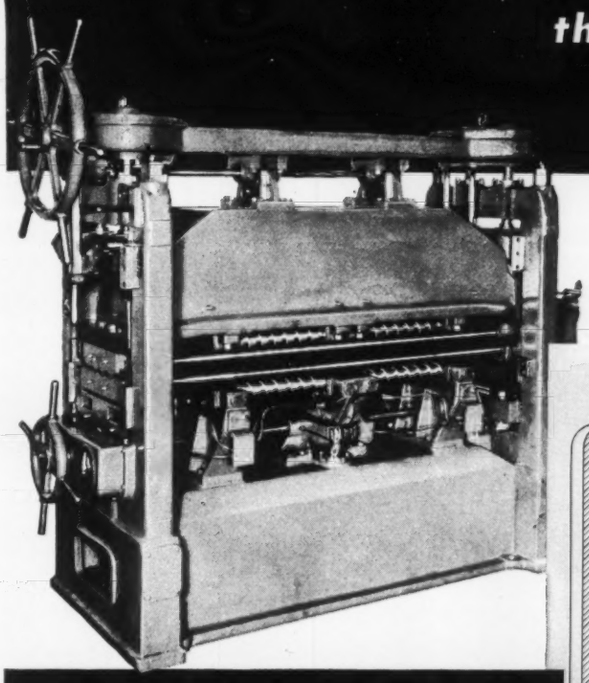

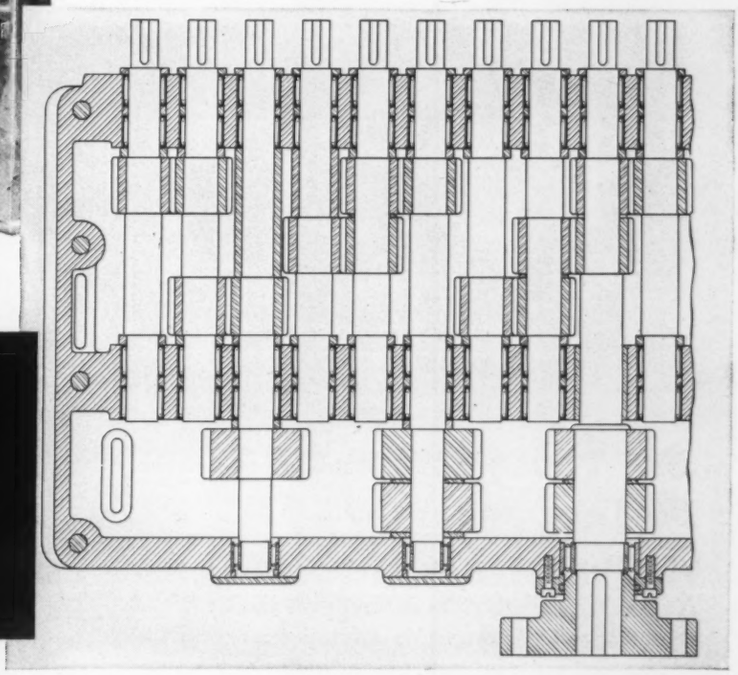

(Above) Maximum anti-friction characteristics in this intricate Leveler assure long, trouble-free performance.

(Right) Cross-section illustrates the compact design made possible with Torrington Needle Bearings. 100 Needle Bearings permit smaller rollers, closer spacing.

EFFICIENCY in a metal straightener is gauged largely by the smallness in diameter of its rollers, and how closely they are spaced. With conventional anti-friction bearings, the factor of bulk naturally limits the size and spacing of the rollers. Take the case of the "Patented American Roller Levelers" for example: a metal straightening machine manufactured for J. I. Bernitz, Inc., New York by the Patch-Wegner Corporation . . .

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Noteworthy PATENTS

Shaft Seal Utilizes Bellows

SEALING members are so designed in the shaft seal in *Fig.* 1 that they may be replaced without dismantling unit. Also, increased working pressures act to make the seal more effective. Thus, the strength of spring is not a limiting factor in sealing effectiveness and a relatively weak spring may be employed.

Flooded type seal, a replaceable ring seats against shaft shoulder with neoprene seals and runs integrally with shaft. Remainder of seal is stationary, bearing surfaces being between carefully finished surfaces. Nosepiece on stationary ring is lead bronze alloy welded to supporting collar. Ring is designed with larger diameter sealing element against shaft shoulder

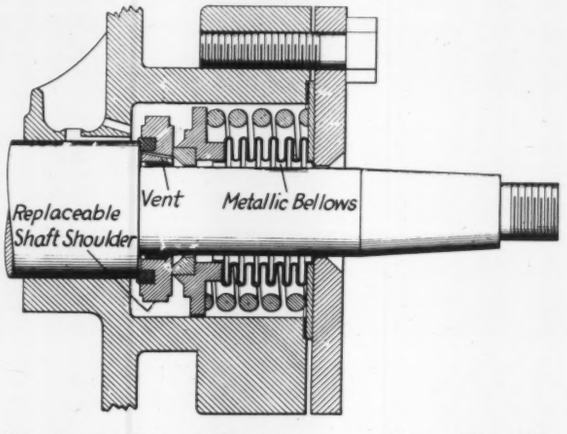


Fig. 1—*Sealing elements are readily replaceable without dismantling unit. Metallic bellows with atmosphere vent assure pressures increase seal*

so increasing pressures hold seal with more force against shaft shoulder. This feature makes seal applicable for high pressure compressor service.

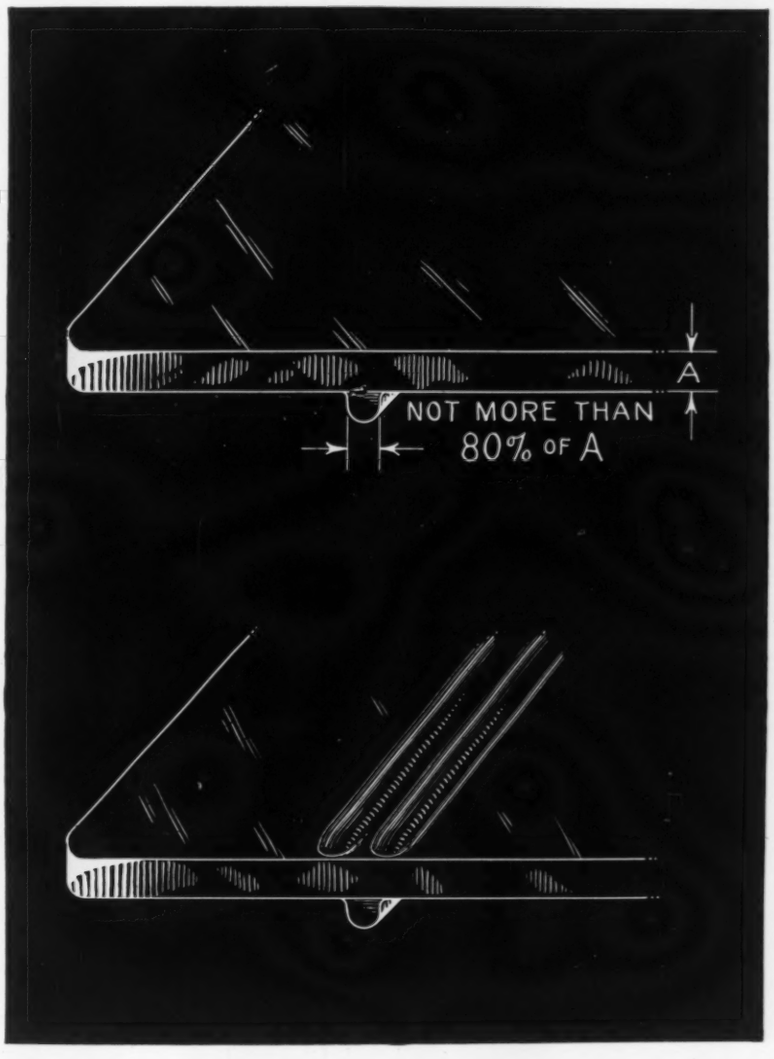
Resilient metallic bellows, hermetically sealed between outside washer and the stationary ring, allow a vent to atmosphere from shaft shoulder. With the pressure built up by the compressor this provides a positive pressure between all sealing elements. That is, larger areas are acted on by compressor pressure in direction of sealing action.

Pocket which lubricates shaft also lubricates seal

NUMBER 4 OF A SERIES

Designing FOR DIE CASTING

— Shadow Marks Can Be Avoided



● In designing for ZINC Alloy Die Casting, the thickness of bosses, ribs, and studs must be considered in relationship to the thickness of the casting to avoid shadow marks. These marks appear on smooth surfaces of thin section directly opposite projections used on the back. Actually, they are minute depressions which are caused by uneven cooling, resulting in shrinkage.

It is known that shadow marks can be avoided if the thickness of the casting is kept above .100", or if the width of the underlying bosses, ribs or studs is kept to a maximum of 80% of the wall thickness. If it is undesirable or impractical to employ either of these methods, the system of covering the marks through the use of some inexpensive external design can be used to good advantage (see lower drawing).

This is the fourth advertisement in a series, appearing currently in these pages, covering the major factors involved in "Designing for Die Casting." A new book bearing this title may be obtained from any commercial die caster—or by writing to The New Jersey Zinc Company, 160 Front Street, New York City.

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surfaces and floods entire seal chamber. Any leakage would readily be detected by oil bubbles along drive shaft. This seal is designed by Frank T. Grothouse and is assigned to General Electric in patent 2,188,784.

Intermittent Operation Increases Life

DEPENDABLE ignition is a prime consideration in design of all automatic fuel burner systems. Also, intermittent operation of pilot further increases automaticity and useful life of unit. These features have been incorporated in the burner illustrated in *Fig.* 2 and covered by patent 2,192,631. Designed by V. O. Beam this invention is assigned to Bryant Heater Co.

Bimetal elements control the operation of the pilot valve and initiate the burner valve operation through an electric circuit controlling a solenoid valve. When thermostat calls for heat, a heating element on bimetal strip in pilot valve is energized. This heating warps the strip and opens a valve allowing fuel to flow through the pilot tube. Movement of the bimetal strip also closes contacts for an igniter coil. Heat of ignited gas then expands the bimetal switch which, through a

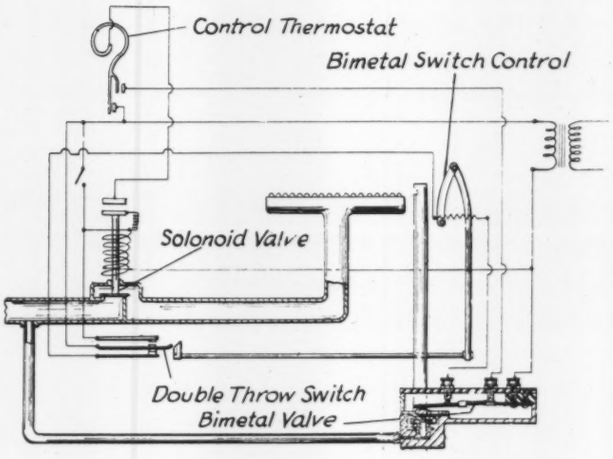
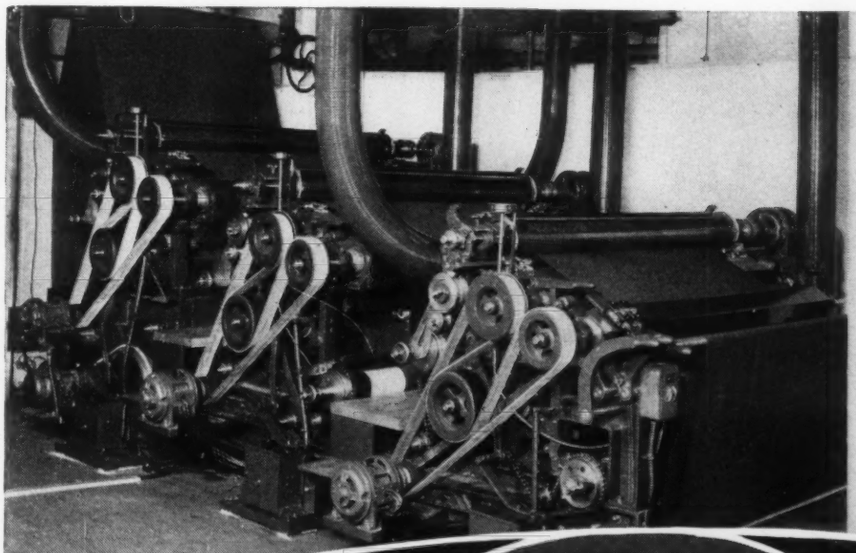


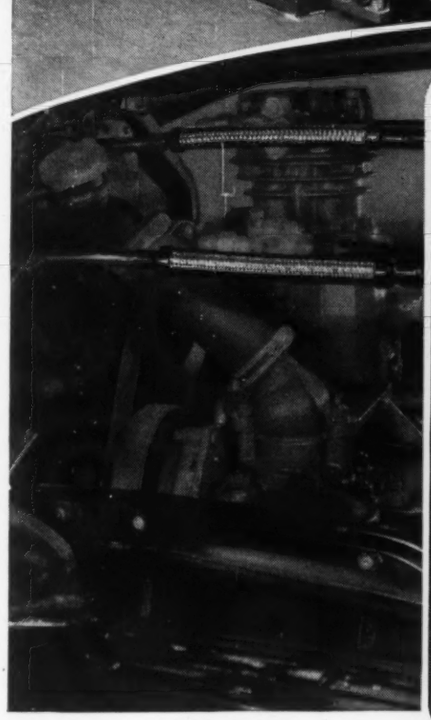
Fig. 2—Automatic ignition system provides dependable operation through interlocking controls

lever arm, controls a double throw switch. Expansion energizes solenoid valve, de-energizing igniter.

When this valve opens, main fuel supply is fed to the burner and is ignited from the pilot tube. These conditions are maintained as long as the thermostat calls for heat. As the thermostat approaches its heated position, contacts controlling pilot separate first. Further movement separates contacts for solenoid holding circuit and main valve closes. In the cycle, before main valve is opened by action of double throw switch, igniter coil operates intermittently because of the voltage characteristics of the transformer. When bimetal strip is heated sufficiently to close circuit for igniter coil, the voltage drop causes a cooling of the heating coil and bimetal opens igniter circuit. Heating again closes circuit of igniter. Thus intermittent operation is continued until main valve opens.



This textile machine works like an electric shaver. As the cloth goes through it—rotary shears "mow" the fabric. Important to the machine's efficient operation is the removal of the flock (textile clippings) resulting from the shearing. A vacuum system was designed using flexible 7" I. D. American Metal Hose which you see here curving gracefully and easily to where it is needed. Because it is metal, it will last. Because it is economical in initial cost, and more so in service, design engineers are using it more and more in vacuum systems for the withdrawal of dust, fumes and grindings.



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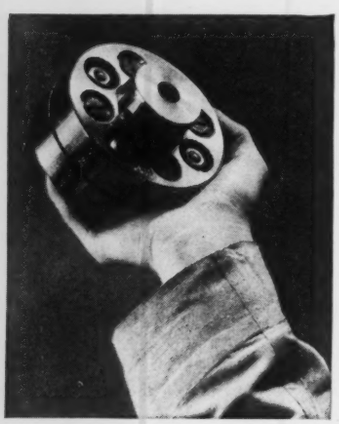

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Applied Mechanics

By Alfred P. Poorman; published by McGraw-Hill Book Co., New York; 354 *pages,* 6 *x* 9 *inches, cloth bound; available through* MACHINE DESIGN *for* $2.75 *postpaid.*

Fourth edition of this textbook, first published in 1917, includes additions and rearrangement of material. Two features of the first edition are still retained, namely, extended use of the graphic method of solution and the large number of illustrative examples which are solved in detail to show the relation between the principle developed and the problems to which it applies.

Since coplanar force systems are usually simpler to solve than noncoplanar systems, they are given first in the order of their simplicity. Kinematic or pure-motion discussion has been combined in one chapter, and new material has been included in the chapter on moment of inertia of mass.

□ □ □

A Dictionary of Metals and Their Alloys

Edited by F. J. Camm; published by Chemical Publishing Co. Inc., New York; 245 *pages,* 5½ *x* 8½ *inches, cloth bound; available through* MACHINE DESIGN *for* $3.00 *postpaid.*

The constantly growing list of new alloy metals, each having special properties and intended for particular uses, makes this book a useful one, since it gives analyses and characteristics of practically all known metals. Cross-referencing enhances its handiness. Special brief sections are included on hardening, electroplating, metal spraying, rust-proofing, and useful tables.

□ □ □

Machine Design Drawing Room Problems

By C. D. Albert; published by John Wiley & Sons Inc., New York; 441 *pages,* 6 *x* 9 *inches, cloth bound; available through* MACHINE DESIGN *for* $3.50 *postpaid.*

Aim of this textbook in its third edition is to present complete material for a drawing room course in general machine design and is based on the belief that complete, comprehensive problems are superior for study over problems dealing with unrelated details or

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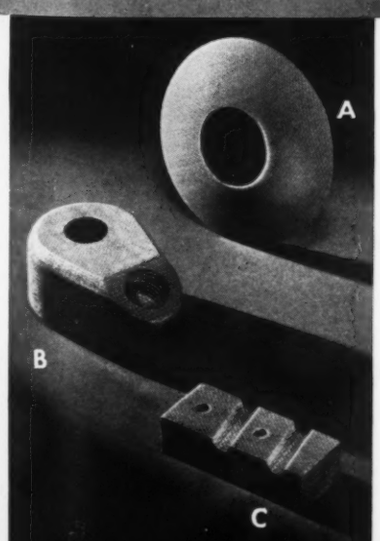

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groups of details. In this edition five of the seven design problems of the second edition have been retained and revised. Particularly helpful to designers are the last nine reference chapters. Last two chapters contain a major part of the information in tabular form.

Standards Proposed for Surface Quality

AFTER ten years of study, the American Society of Mechanical Engineers has published a proposed American standard of surface roughness, with the joint sponsorship of the Society of Automotive Engineers under the auspices and procedure of the American Standards association. As was pointed out in the article, *How Smooth is Smooth?*, M. D., August, 1939, the need for clarification of the concept "surface quality" is particularly important to the designer, who must determine and specify the kind of surface quality a part must have. The same article also gave advance information on some of the material contained in the proposed standard.

No attempt has been made in the standard to cover related considerations like the suitable grade of surface roughness adequate for a specific part; the procedure for obtaining that grade of surface quality; measurement of the roughness; nor such surface characteristics as luster, color, resistance to corrosion, size and shape of surface flaws, hardness, etc. Instead, emphasis is placed on the average deviation from the nominal surface, i.e., the root-mean-square average.

In addition to the common character V for indicating finish on a surface, a numerical symbol in the opening of the vee has been added to denote the standard grade of surface roughness permissible on a specified surface, as $\overset{2}{\mathrm{V}}$. Numerical values of the symbols for roughness are defined in the following table, along with approximations (for illustration only) of applications.

Specification for Surface Roughness

Roughness symbol	R/M/S Height of Irregularities		Examples
	Inches	Microinches	
63M	.063	63000	Rough castings, machining
16M	.016	16000	" " "
4M	.004	4000	" " "
1M	.001	1000	Turning, milling
250	.00025	250	" "
63	.000063	63	" "
32	.000032	32	Fine finishing, shiny
16	.000016	16	" " "
8	.000008	8	" " "
4	.000004	4	Very fine finishing
2	.000002	2	" " "
1	.000001	1	" " "
½	.0000005	½	Highly polished finishes
¼	.00000025	¼	" " "

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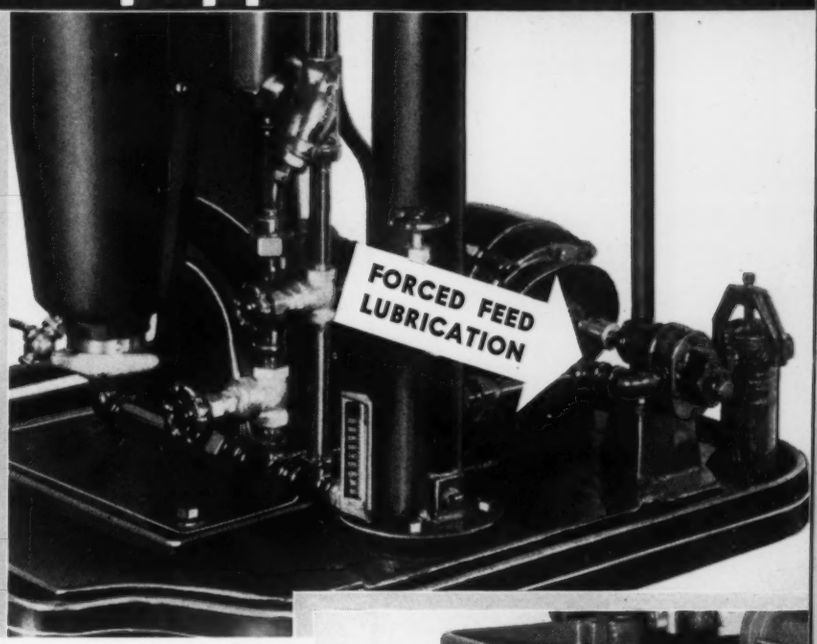

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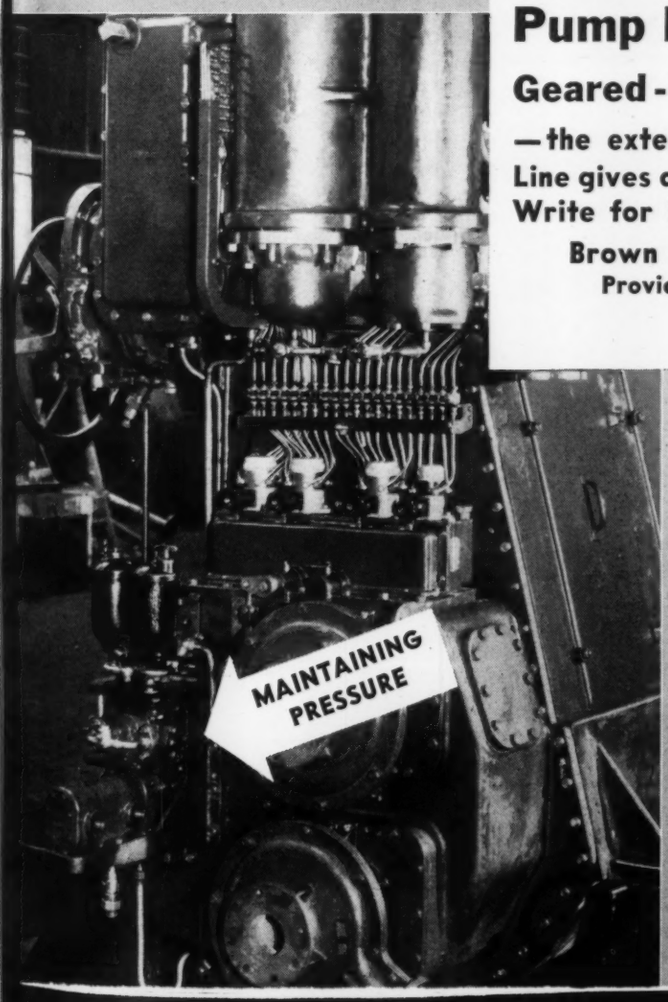
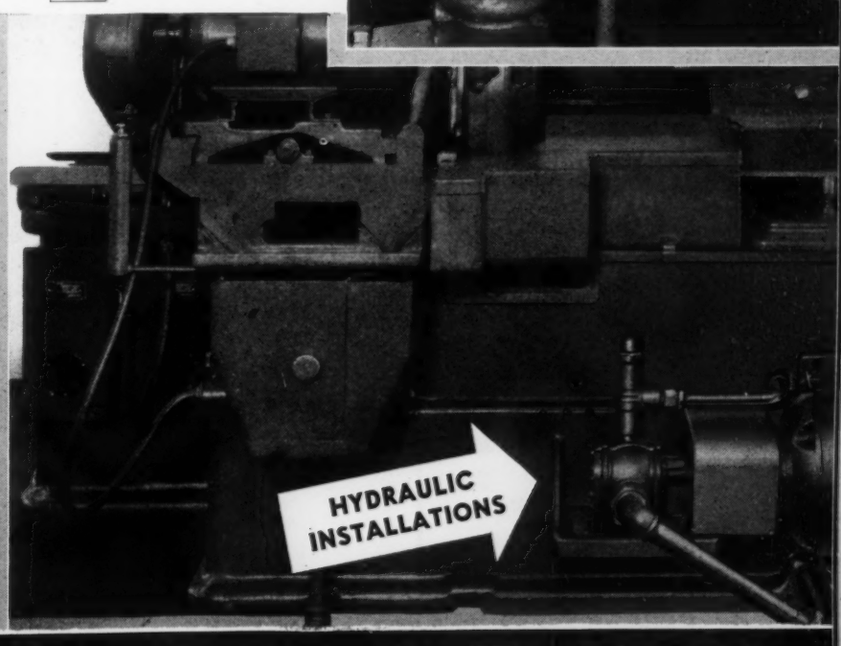
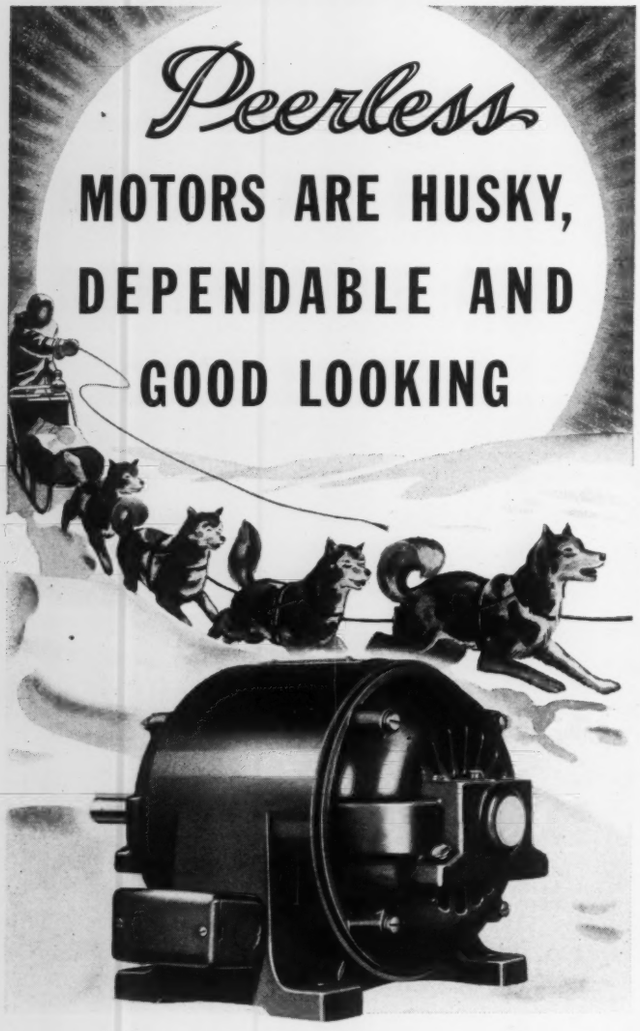
B·S





BROWN & SHARPE



● Peerless Motors are built to take the hard going yet with all their huskiness comes plenty of "eye appeal." They will not only dress up the appearance and enhance the value of any piece of equipment but go a long way in increasing the life of that equipment.

They have plenty of stamina and reserve power to handle heavy loads and are absolutely dependable. Peerless' field of activity is focused entirely on the fractional to 10 H.P. field which accounts for their general widespread acceptance as the outstanding motor buy in the market.

Write for more detailed information or better yet let us have your motor problems. Without any obligation our engineers will prove to your satisfaction, that Peerless Motors on your own equipment are a better buy based on performance.

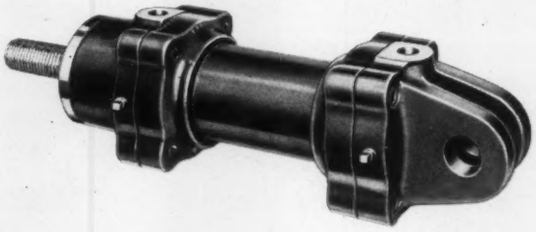
47 YEARS OF LEADERSHIP

PEERLESS ELECTRIC CO.
WARREN, OHIO

New PARTS AND MATERIALS

Swivel Mounting Cylinders Added

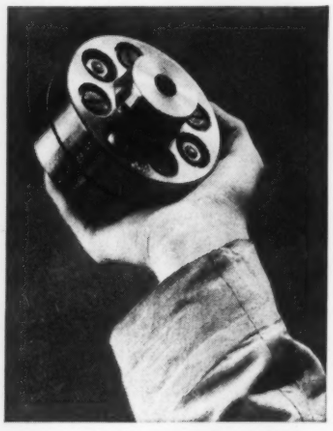
A STANDARD swivel mounting type, Models BN and B2N, has been added to its line of high pressure hydraulic cylinders by Hannifin Mfg. Co., 621 South Kolmar avenue, Chicago. Model BN is a high pressure hydraulic cylinder with a small diameter piston rod. Model B2N is a high pressure unit with a 2 to 1 differential piston rod. Either model is available with an adjustable cushion on either or both ends. The swivel mounting illustrated is an addition to six other standard types of mountings available, including flange, foot, side, and combination flange and foot mountings.



Standard swivel-mounting type has been added to line of high pressure hydraulic cylinders

Flexible Couplings Increase Line

TWO forged steel flexible couplings with 1⅛ and 1⅝-inch maximum bores respectively have been added to the line made by Ajax Flexible Coupling Co., Westfield, N. Y. Specially designed to meet the trend toward alloy steel shafts carrying a high percentage of their torque capacity, these couplings have flanges forged from SAE 1020 steel. The new sizes are built on the same principle as larger sizes. Rubber bushings and

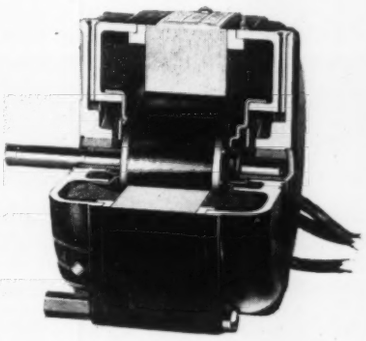


Flexible couplings are designed to meet trend toward use of alloy steel shafts carrying high percentage of torque capacity

graphite bronze bearings provide resilient flexibility, positive drive, free end float, elimination of noise, backlash and lubrication problems.

Three Windings Available on Motor

DESIGNED as a capacitor motor, a new small motor announced by Bodine Electric Co., 2258 West Ohio street, Chicago, can be supplied with three different windings—synchronous capacitor, nonsynchronous capacitor and dynamic braking capacitor. Weighing less than 1½ pounds, the motor is 2⅜-inches



Small capacitor motor can be supplied with windings as synchronous capacitor, nonsynchronous capacitor and dynamic braking capacitor

wide and high, with 1⅝-inches overall length, excluding the ⅝-inch long shaft. Standard ratings on 60 cycles are respectively, 1/1500-horsepower at 1800 revolutions per minute, 1/1000-horsepower at 1700 revolutions, and 1/1500-horsepower at 1200 revolutions. Motor input is 8 watts or less. Normally three leads are brought from the motor and it can be reversed, even when running, by means of a single-pole double-throw switch. The capacitor furnished with the motor has a bracket for separate mounting. Operation is at 110-volts alternating current, but motors wound for lower voltages can be built on order. On higher voltages a transformer is necessary. Motors for lower frequencies can also be supplied. Sleeve bearings are standard, ball bearings optional.

Starter Incorporates Improvements

IMPROVEMENTS have been made in the Bulletin 9586 across-the-line starter announced by Cutler-Hammer Inc., Milwaukee, for control and protection of polyphase squirrel cage motors up to 5-horsepower. These refinements include: Streamlined, simplified,

For control and protection of polyphase squirrel cage motors up to five-horsepower, across-the-line starter has been improved

hook-on cover, held by one screw, removable for easy installation; removal of operating mechanism by loosening one screw; contacts of heavier fine silver, with lava

Allis-Chalmers RULE OUT DOUBTFUL SCREWS!

No "doubtful" screws for this transformer case

THEY SPECIFY QUALITY-CONTROLLED PARKER-KALON SOCKET SCREWS

Careful buyers like Allis-Chalmers take no chances on "doubtful" socket screws in their equipment. They specify Parker-Kalon and escape the "doubtful few" . . . those few imperfect screws in a box that might delay assembly work or fail in service.

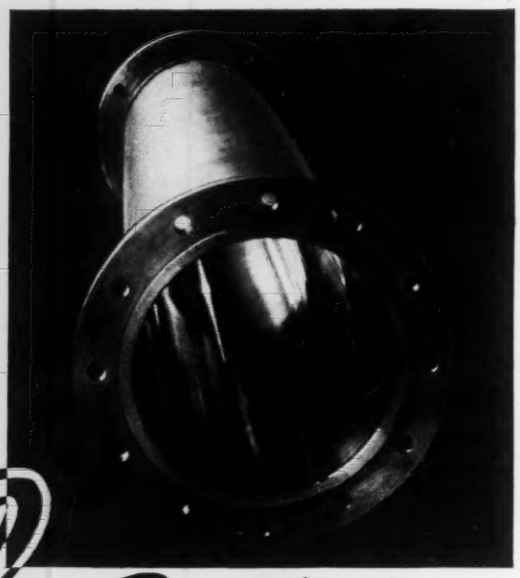
Parker-Kalon Socket Screws are produced under a rigid control routine made possible only by Parker-Kalon's unique Quality-Control Laboratory. Sixteen exacting tests and inspections insure that every screw in a box is "better than good enough."

Specify Parker-Kalon next time . . . they cost no more. Look for the Quality-Control Guarantee that vouches for their extra quality. For free samples and local distributor's name, write: Parker-Kalon Corp., 192-200 Varick Street, New York.

Quality-Controlled

16-point test and inspection routine covers: Chemical Analysis; Tensile and Torsional Strength; Ductility; Shock Resistance under Tension and Shear; Hardness; Head diameter, height and concentricity; Socket shape, size, depth and centricality; Class 3 Fit Threads; Clean-starting Threads.

PARKER-KALON
COLD-FORGED
Socket Screws

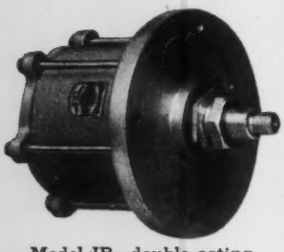


16-in. honed cylinder bore

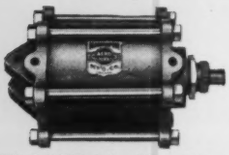
2 Features

for Better Cylinder Performance

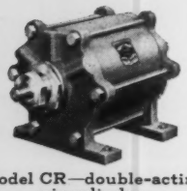
1. Hannifin Pneumatic Cylinders, including even the largest sizes, are bored and then honed on special Hannifin long stroke honing machines, producing a better finish that means better cylinder performance.



Model JR—double-acting air cylinder



Model BR—double-acting air cylinder



Model CR—double-acting air cylinder

2. Simple outside adjustment of piston packing allows a high efficiency piston seal to be easily maintained. The soft, graphite treated piston packing and the straight, round, perfectly smooth cylinder bore prevent leakage and waste of air power, and cut friction loss to the minimum.

Hannifin pneumatic cylinders are built in a full range of standard mountings, 1 to 16 in. diameter, for any length stroke. Both single and double-acting types available, with or without air cushion. Write for Bulletin 34-MD with complete descriptions of all types.

HANNIFIN MANUFACTURING COMPANY
621-631 South Kolmar Avenue
Chicago, Illinois

ENGINEERS • DESIGNERS • MANUFACTURERS

Pneumatic and Hydraulic Production Tool Equipment

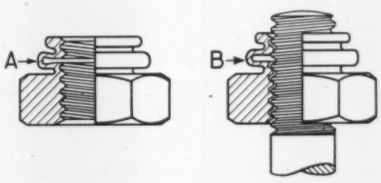
HANNIFIN

Pneumatic CYLINDERS

insulators to protect contact springs against even minor heat transmission, and stainless steel contact springs and supports to resist rust; overload relay made smaller and more accessible, with overload trip indication. This starter is available in the following types of cover control: Reset only for 2 or 3-wire remote control; start and stop reset buttons for 3-wire control; three-position selector switch for manual-off-automatic local control or 2 or 3-wire remote control. NEMA type enclosures for the starter include general purpose, watertight, dust-tight and Class I-D or II-G.

Self-Locking Nut Announced

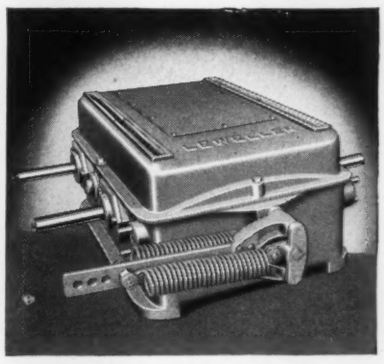
AN EFFECTIVE, one-piece, all-metal nut designed to withstand the most severe vibration, the Boots self-locking nut is announced by Scovill Mfg. Co., Waterbury, Conn., licensee of Boots Aircraft Nut Corp. It is essentially two nuts in one with the top section displaced in a downward direction so that its upper locking threads are out of lead with respect to the load-carrying threads of the lower section. The two sections are connected by a spring member which is an integral part of the nut. In the illustration, *A* shows the nut spring member in its displaced position when not engaged with a screw or bolt, while *B* shows the position of the spring member when the nut is engaged. Upon insertion of a bolt the spring member allows the top section of the nut to be extended to permit it to engage properly with the threads of the bolt. A force is thus established which firmly grips the nut without damage to the threads of the screw or bolt and accommodates all thread variations. At present these nuts are available in sizes from No. 8 to ¾-inch inclusive, in a variety of metals.



Designed to withstand severe vibration, one-piece, all-metal nut is essentially two nuts

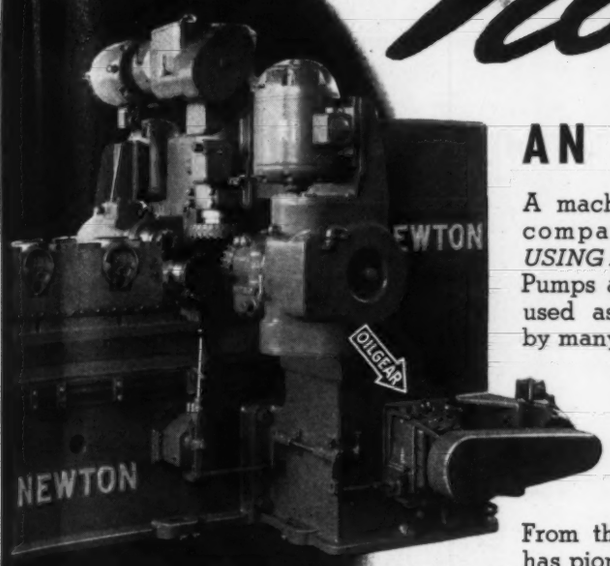
Transmission Regulates Stoker

DESIGNED to regulate stoker speeds for feeding fuel at rates to maintain the boiler pressure setting automatically, a new transmission has been developed by Lewellen Mfg. Co., 1010 East Tenth street, Columbus, Ind. The control attached to the boiler is set for any desired steam pressure and a slight deviation of this pressure results in a movement of the control which is



Boiler pressure is preset by control, slight deviation of pressure moving control connected to safety lever of new transmission

SUCH PREFERENCE FOR OILGEAR IS *Not* AN ACCIDENT



Oilgear powers the feed and rapid traverse of this Newton Straight Line Unit Head Milling Machine. The makers, the Consolidated Machine Tool Corp., have used Oilgear extensively since October 1926.

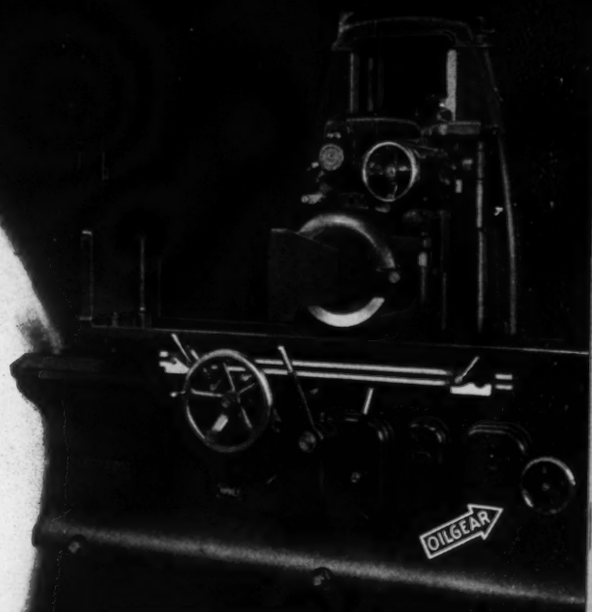
A machine is known by the companies that *KEEP ON USING IT!* Oilgear Fluid Power Pumps and Motors have been used as standard equipment by many leading machine and machine tool manufacturers for periods ranging from 10 to 17 years. *Such preference must be merited,* as you well know.

From the beginning, Oilgear has pioneered the outstanding advances in fluid power applications. Today, Oilgear pumps and motors are better than ever, simpler, more efficient. They provide safe, cushioned power at operating speeds impossible to secure in any other way. They reduce tool breakage and permit wider latitude in tool and work material. They reduce normally high maintenance, synchronize production, provide exceptional flexibility and precision of control and convenience in operation.

We suggest you get *all* the facts about this *better* fluid power equipment. Send the handy coupon for the 64-page Handbook 47000. Send today. THE OILGEAR COMPANY, 1310 W. Bruce Street, Milwaukee, Wisconsin.

OILGEAR

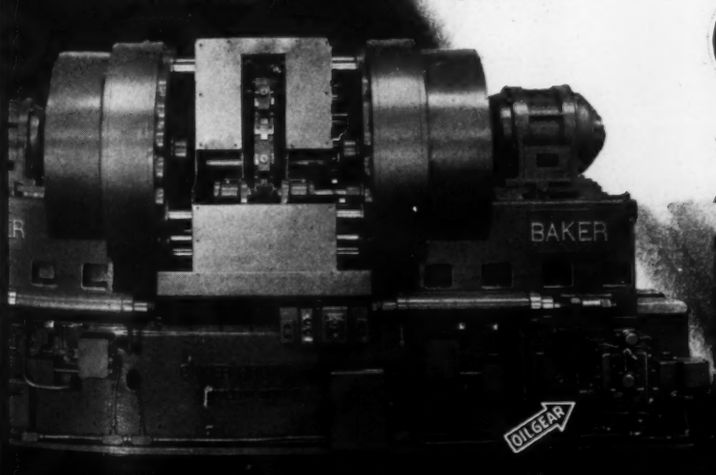
Trademark
Reg. U. S. Pat. Off



Mattison Machine Works have used Oilgear Feeds since 1928. For their High-powered Precision surface grinder, Oilgear provides steplessly variable table speeds from 30 to 100 feet per minute, quick cushioned reversal, ease of adjustment, manual or automatic control, etc.

Users of Oilgear since July 1927 C. B Cottrell & Sons Company chose Oilgear Feeds for their modern, precision Claybourn Roughing and Shaving Machine

Baker Brothers have used Oilgear since 1925. Shown below, the 2-way drilling, reaming, counter-boring and facing machine with Oilgear Fluid Power Feed.



OILGEAR

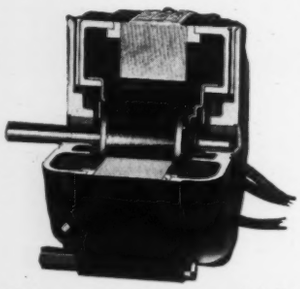
THE MOST EFFECTIVE APPLICATION OF *fluid power*

The Oilgear Company
Please send
Name
Company
Address
State

A powerful new MIDGET MOTOR

for precision instruments, timing devices, etc.

Although only 2⅜ in. high, the new Bodine Type K motor has distributed windings, precision-ground shaft, diamond-bored sleeve bearings or ball bearings, and other features heretofore possessed only by larger motors. Having a normal output of 1/1500 hp. on continuous duty, with greater output for intermittent service, this motor is especially suited for timing devices and other equipment requiring relatively low output and steady, trouble-free service.



Cutaway view, showing details of frame, rotor, and windings.

This new motor is available in the three-wire, capacitor type (Type KYC), and non-synchronous capacitor type (Type KCI). The latter can be modified to facilitate dynamic braking. Bodine Electric Co., 2258 W. Ohio St., Chicago.

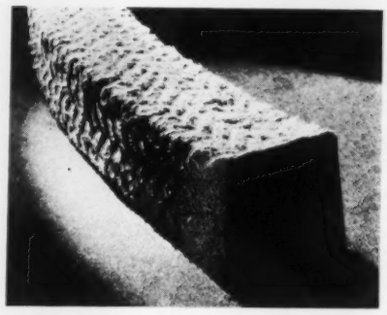
SEND FOR NEW BULLETIN

BODINE MOTORS
ENGINEERED FOR YOUR PRODUCT

connected to the safety lever on the transmission. While the lever follows any rapid motion of the controlling device, speeds are adjusted only at a safe controlling rate of acceleration. When the boiler pressure returns to the preset figure, the safety lever has reset for the operating position and the speed to which the transmission has been changed is maintained until another change takes place in the pressure.

Lattice-Braid Packing Introduced

LATTICE-BRAID packing has been introduced by Garlock Packing Co., Palmyra, N. Y. Greater strength is claimed because the strands are strongly lattice-linked together and wear resistance is greater

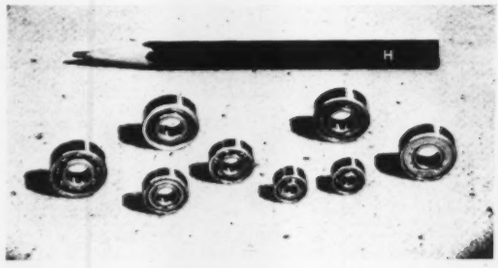


Every strand in new lattice-braid packing passes diagonally through the body of the packing at 45-degree angle

because the packing will not disintegrate into loose strands. Flexibility and controlled porosity impart a semi-automatic pressure action. Every braiding strand passes diagonally through the body of the packing at an angle of approximately 45 degrees, making for a completely unified structure and internal as well as external braiding.

Small Bearings Made with Retainers

SMALL precision ball bearings made by Norma-Hoffmann Bearings Corp., which were hitherto available in the full or retainerless type, can now be obtained as standard with retainers or ball cages. Bores range



Hitherto available only in full or retainerless models, small ball bearings are now furnished with retainers

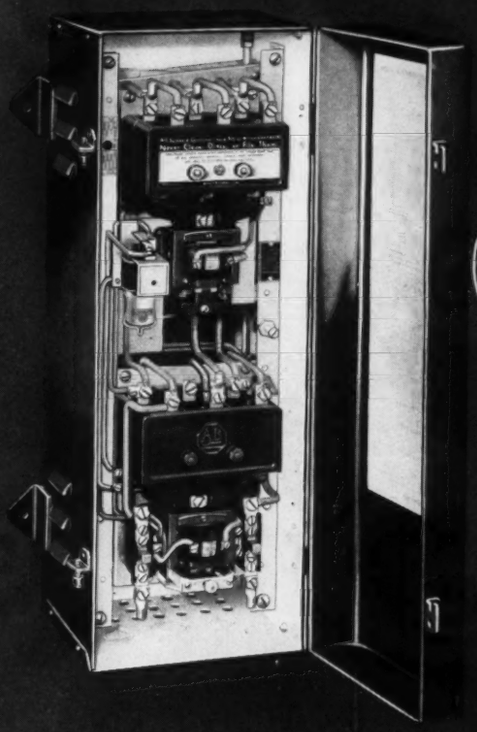
from ¼-inch to ⅛-inch, with outer diameters of ⅝ to ⅜-inch and widths from .196 to 5/32-inch.

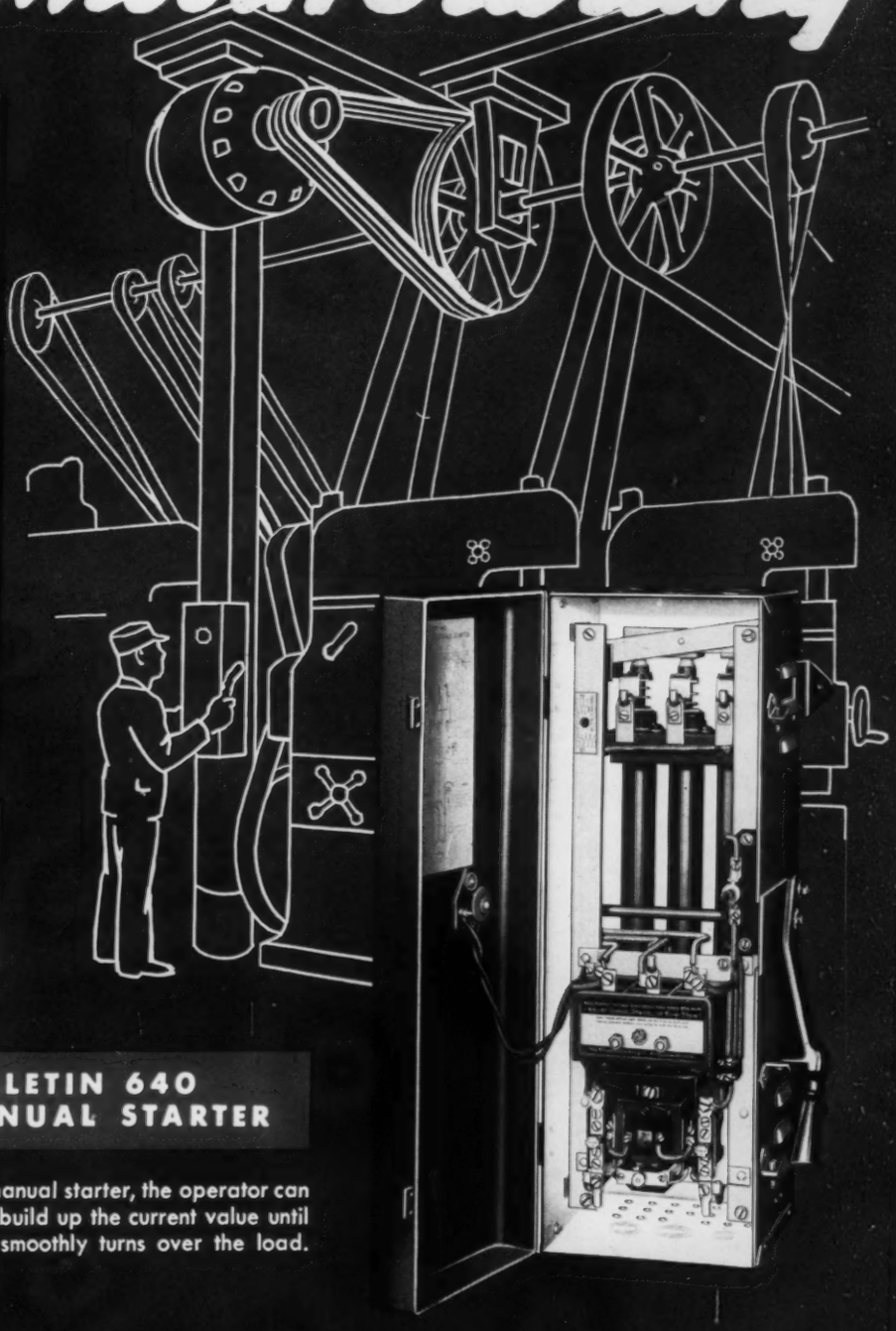
Enamels Bake Quickly

TWO lines of enamels, especially designed to work at high speed baking schedules in infra-red lamp ovens, are announced by Maas & Waldstein Co., Newark, N. J. Use of these enamels permits taking advantage of the principal features of the infra-red lamp ovens—more rapid baking, very short warming-up periods, little wasted heat to make the drying room

For Machines that need

Velvet-Smooth Starting





BULLETIN 740
AUTOMATIC STARTER

This single-step automatic starter, with its compression resistors, provides smooth acceleration for squirrel-cage motors.

BULLETIN 640
MANUAL STARTER

With this manual starter, the operator can gradually build up the current value until the motor smoothly turns over the load.

ALLEN-BRADLEY

COMPRESSION RESISTANCE STARTERS

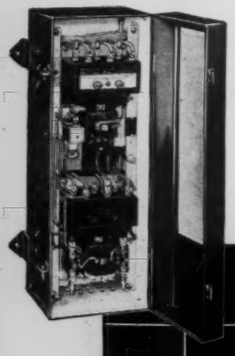
QUALITY

How to get VELVET-SMOOTH ACCELERATION

Avoid Shock

to gears and connected machinery

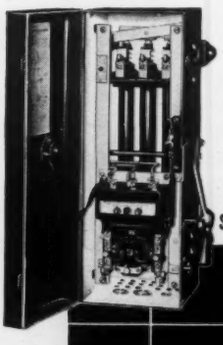
There are many applications where it would be highly desirable to start squirrel-cage motors smoothly, without shock—either to improve the product or to reduce wear and tear on belts, gears, and connected machinery. Here is where one of the starters described below fits ideally into the picture.



For Automatic Starting

The Bulletin 740 starter is controlled by push buttons or other pilot device. The Bradleyunit compression resistors can be easily adjusted to meet exactly the starting torque requirements of the motor load.

SPEED-TIME CURVE OF BULLETIN 740 STARTER



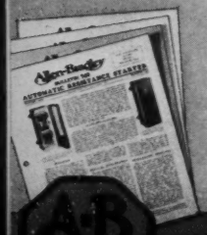
For Hand Starting

With the Bulletin 640 starter, the operator has the motor starting speed under his full control. Thus, shock to connected machinery can be eliminated. By reducing machine wear and tear, maintenance expense is saved.

SPEED-TIME CURVE OF BULLETIN 640 STARTER

Send for these

REDUCED-VOLTAGE STARTER BULLETINS



Includes bulletins on manual and automatic resistance type starters and on automatic transformer type starters.

Allen-Bradley Co.
1333 S. First Street
Milwaukee, Wisconsin

Please send me your bulletins on reduced-voltage starters.

NAME _____

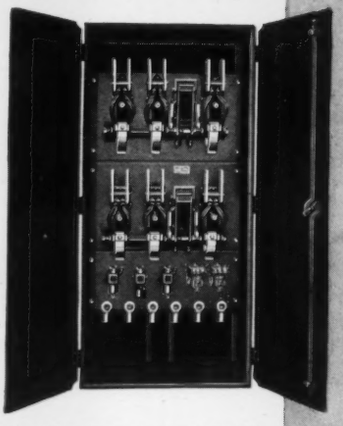
COMPANY _____

STREET _____

CITY _____ STATE _____

Large and Small Sizes for Every Industrial Need

Allen-Bradley compression resistance starters have been used by industry for many years to control conveyors, textile machines, punch presses, wire drawing machines, line shafts, V-belt drives, band saws, chain drives, and other such equipment. Available in capacities up to 250 hp, 220-440-550 v.



Bulletin 740 starter, rated 250 hp, 220 volts, showing main contactors and auxiliary relays.

ALLEN-BRADLEY

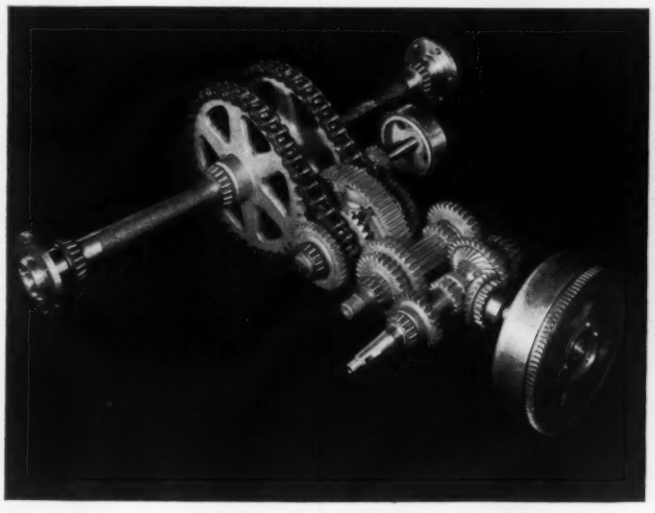
MOTOR CONTROL

QUALITY

Down On the Farm

WHITNEY CHAINS

Help Case Implements Make the Crops



Left: *Whitney Roller Chains on final drive of Case Tractor, Model DC.*

Top: *Raking with Model D C Tractor, made by J. I. Case Co., Racine, Wis.*

Directly Above: *Case's new small-size combine, Model A6, uses Whitney Chains.*

The intensive work of modern power-farming often calls for long stretches of night-and-day tractoring. So to assure smooth operation, full power and long life, all Case tractors have the extra strength of Whitney Roller Chains built into their final drives. *And these Whitney Drives have always stood up under every work-requirement, no matter how severe.*

This famed implement builder also employs Whitney Drive and Conveyor Chains on other equipment like the popular new combine shown . . . to complete their guarantee, to the farmer, of inbuilt quality that means uninterrupted service. And *you* can give *your* customers this same guarantee. Write for Whitney Catalog V-145.

WHITNEY CHAINS

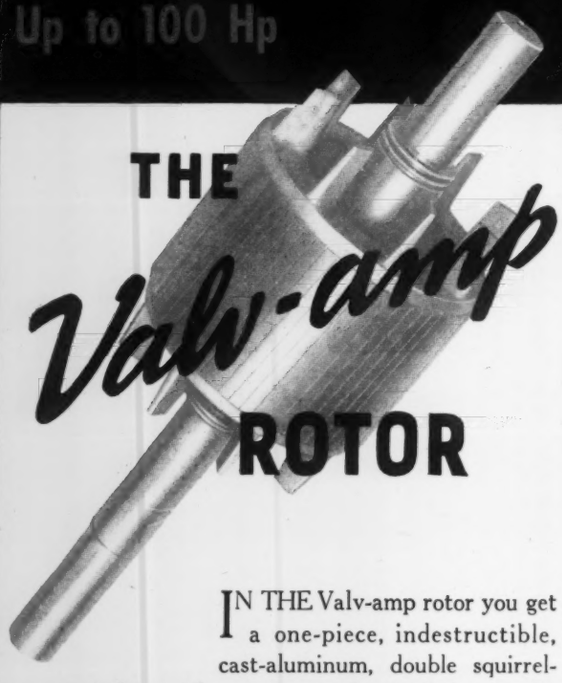
OTHER WHITNEY PRODUCTS

Roller Chain & Sprockets, Silent Chain & Sprockets, Conveyor Chain & Sprockets, Roller Chain Flexible Couplings, Automatic Load Limiting Sprockets, Automatic Drive Tensioners, Woodruff Type Machine Keys and Cutters.

THE WHITNEY CHAIN & MFG. CO., HARTFORD, CONN.

NOW . . .

A Cast-aluminum Rotor for High-starting-torque, Low-starting-current Motors Up to 100 Hp



THE *Valv-amp* ROTOR

IN THE Valv-amp rotor you get a one-piece, indestructible, cast-aluminum, double squirrel-cage winding with permanent electrical characteristics. There are no soldered, welded, or brazed joints. This cast construction, with the fans cast integrally with the winding, makes the rotor compact, and assures rapid dissipation of heat losses during starting. Valv-amp is finding ready acceptance in driving air-conditioning and commercial - refrigeration compressors, and other machinery having high torque requirements, where starting current is limited. Write your G-E Office, or General Electric, Schenectady, N. Y., for Valv-amp descriptive bulletin GEA-3347.

BENEFITS YOU GET WITH THE VALV-AMP

1. Simplicity of Construction.
2. Accurate Mechanical and Electrical Balance
3. Long Motor Life
4. Uniform Characteristics —a casting operation eliminates the human element in rotor fabrication

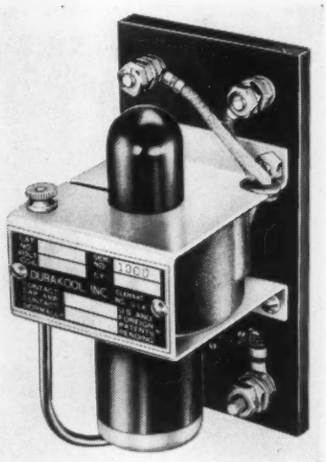
See the G-E "House of Magic" at Both Fairs

GENERAL ELECTRIC

uncomfortable, and a fraction of the floor space needed by fuel-fired ovens. This type of baking is also especially suitable for use with conveyor systems. The new lines are Raydur synthetic baking enamels, supplied in high gloss and semigloss finishes, and Raydur Duart wrinkle enamels, supplied in grades to form fine, medium and coarse patterns. Both will bake to a hard, durable surface in 15 to 20 minutes and can be handled for assembly half an hour later with little danger of marring. Color retention is good, and adhesion on metals and molded plastics is excellent. Both enamels are furnished in black, white and most colors.

Mercury Relay Announced

UTILIZING the unbreakable metal body of the Durakool mercury switch and the displacement principle with solenoid actuation, a new mercury relay is announced by Durakool Inc., Dept. M, Elkhart, Ind. The contact structure is hermetically sealed, making the relay especially suitable for use in corrosive or explosive atmospheres. With little friction and no wear in operation, the relay may be operated up to 300 times per minute, and no maintenance or attention is required. The durable metal body is specially treated to hold a gas at a pressure of four atmospheres—an important feature in the reduction of ionization between the contacts. Contact resistance is as low as .002 ohms, and on alternating current, as little as 1 watt is required for normal closing operation, and only 1.5 watts for normal opening operation. On direct current, the operating energy required is only .25 watts. The relay is also available for special requirements up to 200 amperes capacity.

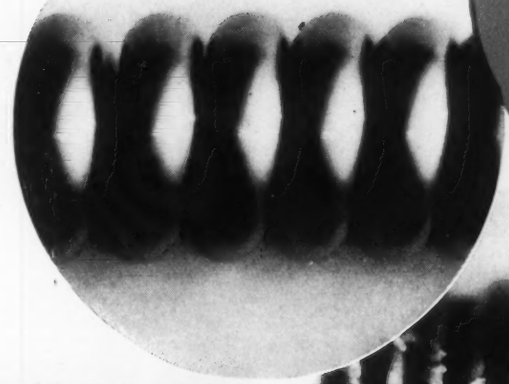


Mercury relay utilizes unbreakable metal body of mercury switch and the displacement principle with solenoid actuation

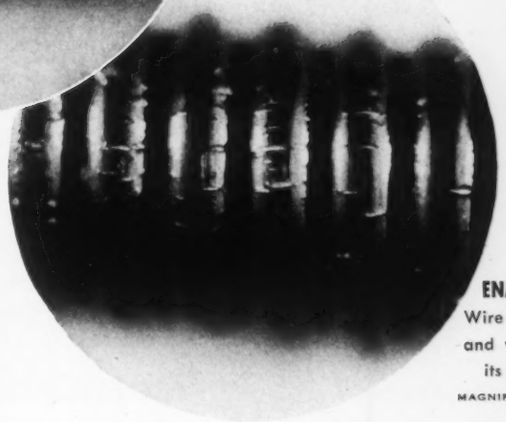
Isolator Controls Vibration

DESIGNED to control machine vibration economically and reduce resulting noise, an easily applied vibration isolator is announced by Johns-Manville, 22 East Fortieth street, New York, and is known as the controlled spring isolator. Working parts consist of a coil spring and a rubber load pad, which support the equipment and isolate vibration, and an adjustable rubber snubber inside the base, which controls excessive motion. Horizontal and torsional as well as vertical vibration is taken care of, tests indicating the unit is particularly efficient for low frequency vibrations resulting from slow speeds along with reciprocal move-

See the S-T-R-E-T-C-H of FORMEX Reg. U. S. Pat. Off. MAGNET WIRE



FORMEX WIRE
Wire stretched 20% and wound on its own diameter
MAGNIFIED ABOUT 15 TIMES



ENAMELED WIRE
Wire stretched 10% and wound on twice its own diameter
MAGNIFIED ABOUT 15 TIMES

TOUGH and FLEXIBLE FILM Cuts Down Rejects

STRETCH or extensibility is one measure of film toughness. It is the property that determines how much winding tension a film will stand without developing cracks. It also indicates ability to stand sharp bends.

With respect to stretch, Formex wire rates high. It is at least three times tougher and more flexible than conventional oil-type enameled wire. See pictures above. It is also much more abrasion resisting. These are the reasons why it is so well suited for modern high-speed winding machines. Definitely, it cuts down on rejects and lowers winding costs. That means savings.

Also—as compared with fabric-covered enameled wire—it takes up less space and saves copper. In most sizes, it costs less per foot. It resists many solvents; it has high dielectric strength and long life.

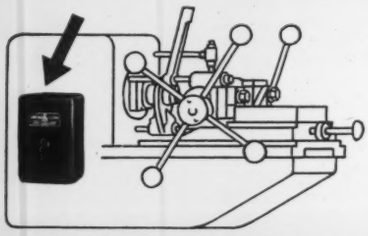
These, and still other properties, make Formex wire worthy of study by every manufacturer who is interested in lowering costs or improving his product. For more details, see Bulletin GEA-2973. Prices, of course, will gladly be furnished. Address nearest G-E sales office or General Electric, Dept. 6C-201, Schenectady, New York. 520-179

FORMEX WIRE IS A PRODUCT OF GENERAL ELECTRIC RESEARCH

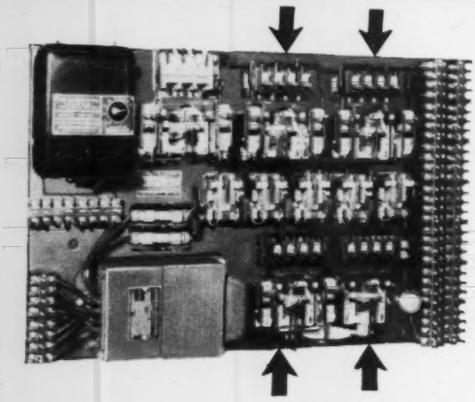
GENERAL ELECTRIC

GENERAL ELECTRIC MAGNET WIRE
ALWAYS THE RIGHT TYPE FOR EACH JOB

ON THE MACHINE—



OR IN THE MACHINE—



The New 'D50

Is in Its Element

"DESIGN us a starter for small motors that will be well suited to use on machine tools." That was the instruction that resulted in the development of the new CR7006-D50. That is why it is a machine-tool starter all the way from its efficient, long-lived, three-leg solenoid magnet to the Flamenol wiring that is oil-resisting.

When you design a machine embodying motors up to the sizes listed below, you'll assure its dependability in the field by specifying the CR7006-D50 starter for its control.

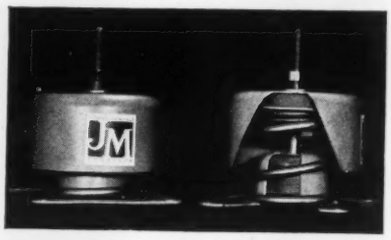
RATING OF THE NEW STARTER

	110 v	220/550 v
Single-phase	1 hp	1½hp
Three-phase	1½ hp	2 hp

General Electric, Section 676-5B
Schenectady, N. Y.
Please send me complete data on the new CR7006-D50 magnetic starter (GEA-3250).
Name.....
Address.....
City.....*State*.....
676-5

GENERAL ELECTRIC

ments. Two sizes are available, small for loads from 60 to 190 pounds per isolator, and the heavy duty, for loads from 250 to 720 pounds. Loaded overall dimen-

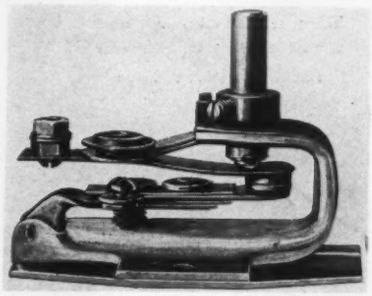


Working parts of vibration isolator are a coil spring, a rubber load pad, and an adjustable rubber snubber inside base

sions are 6 by 6 inches by approximately 3¾-inches high. The isolator is enclosed in a metal jacket which protects the rubber parts from oil and light.

Thermostat Depends on Brass

PRODUCTION of a new type of thermostat for electrically heated appliances is announced by General Thermostat Corp., 389 East 165th street, New York.

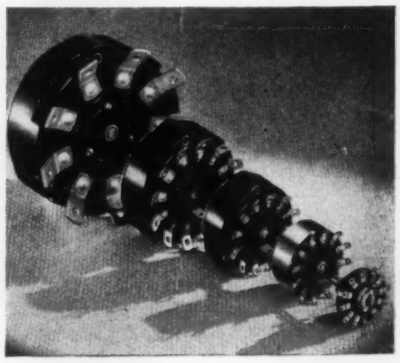


Thermostat for electrically heated appliances depends upon linear expansion of brass for its operation

It employs no bimetal and depends upon the linear expansion of brass for its operation. The thermostat is designated Posi-Trol.

Increase Ratings of Tap Switches

INCREASED ratings have been set for each of the five Ohmite high current tap switch models made by Ohmite Mfg. Co., 4835 Flournoy street, Chicago. Model 111 is now rated at 10 amperes, 150 volts alternating current; Model 212 at 15 amperes, 150 volts; Model 312 at 25 amperes, 300 volts; Model 412 at 50 amperes, 300 volts; and Model 608 at 100 amperes, 300 volts. These ratings apply to alternating current circuits operating



Each of five high current tap switch models has been given increased ratings

at any power factor. Ohmite high current tap switches are multipoint, load-break, nonshorting, single-pole rotary selectors of compact, permanently insulated, cera-

Plastics in Engineering

By JOHN DELMONTE . . . . 6 x 9¼ INCHES . . . . 620 PAGES . . . . CLOTH BOUND . . . . ILLUSTRATED

Now Ready...

the first complete volume written by a recognized engineer—for engineers. Potentialities as well as limitations for all plastic materials are fully covered in terms of the various engineering problems involved. Progress of art and extent of applications are emphasized. Tests conducted by the author support the discussion with conveniently tabulated data.

Physical, chemical and electrical properties are discussed. Included are numerous tables of comparative data and critical evaluation of the single properties of each plastic.

Comprehensive analyses of compression, transfer, injection and cold molding are included. Molding techniques are compared with respect to material selection, economies and various practical problems which may arise. Factors contributing to the costs of molding operations are analyzed. Various methods of finishing are treated and specific recommendations made for different types of work. Information on correct design procedures for molded parts is presented in useful, ready reference manner.

Properties and methods of fabricating various stocks of plastics are discussed with respect to machining, forming, hot swaging, punching and finishing. Particularly significant are the chapters on cast synthetic resins and transparent plastic materials.

Throughout the entire book the decorative appeal of plastics is emphasized with numerous examples to illustrate this phase of design.

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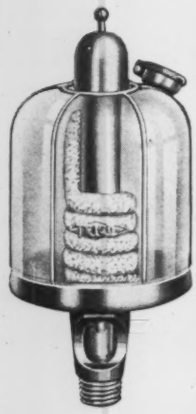
New!!

TRICO

UNBREAKABLE
WICK FEED OILERS



- VISIBLE OIL SUPPLY
- AUTOMATIC OPERATION
- STREAMLINED DESIGN

NOW—replace your old-fashioned trust-to-luck wasteful oil cups that usually run dry when least expected, with this visible ultra-modern WICK-FEED Oiler.
Feed is automatic and positive—at each filling the bearing is flushed momentarily and thereafter the wick feeds oil to the bearing by capillary action. No adjustments are necessary. Dirt and sediment cannot enter bearing. Oil supply is always visible. Beautifully finished in bright cadmium-plate.

Available in five styles; in one, two, and four oz. capacities.

WRITE FOR BULLETIN NO. 27
In Canada—IRVING SMITH LIMITED—Montreal

TRICO FUSE MFG. CO. Milwaukee, Wis.

BLUE Devil
The ARISTOCRAT of SOCKET SCREWS
Try our service on your special sizes.
1—Cold-formed heads—unimpaired continuity of fibres.
2—Tensile strength 215-225,000 lbs. per square inch.

3—Precision formed hexagon socket with true sides and no taper.
4—Chamfered edge knurled to facilitate assembly.
Blue Devil Cap Screws are unbelievably tough, and are heat treated in electrically controlled furnaces. Send for catalogue and samples.

Nothing too large - Nothing too small for
SAFETY SOCKET SCREW CORPORATION
4447 N. KNOX AVE., CHICAGO, ILLINOIS

mic construction and can easily be connected in tandem to form multiple assemblies. With silver-to-silver contacts these switches have slow-break, quick-make action especially designed for alternating current use.

Automatic Reset Timer Announced

AUTOMATIC reset timer announced by the R. W. Cramer Co. Inc., Centerbrook, Conn., consists essentially of an enclosed snap action switch actuated by an operating arm driven in one direction by a small synchronous motor with an enclosed magnetically operated gear clutch and a spring resetting means to the starting position after the time cycle has been completed. Several time ranges are available to meet various timing requirements. The contact has a capacity of 10 amperes at 115 volts or 5 amperes at 230 volts.

Several time ranges are available for various timing requirements of automatic reset timers

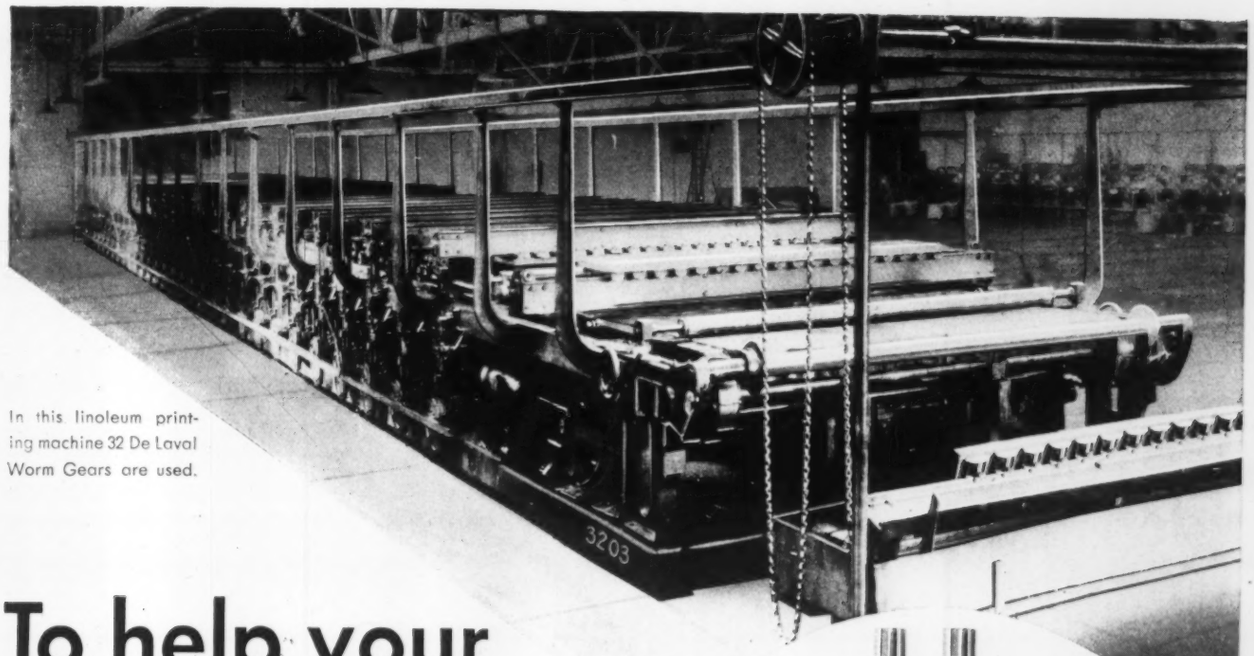
Wick Feed Oiler Announced

FOR use on machinery operating intermittently, a visible, unbreakable wick feed oiler is announced by the Trico Fuse Mfg. Co., 2948 North Fifth street, Milwaukee. The lever at the top, when in a vertical position starts the feed and when flipped to the side shuts off the feed. No flooding and waste of oil results when the machine is idle. Oil supply is always visible and the clear reservoir tells at a glance when refilling is necessary. When the oiler is filled above the point where the wick enters the center tube, the surplus oil drains into the bearings, flushing them thoroughly. When the oil recedes to the opening in the tube, the wick automatically feeds oil to the bearing by capillary action. Dirt or sediment cannot enter the bearing. The oiler is made in three styles, in 1, 2 and 4-ounce capacities.

Engineering Dept. Equipment

Sound-Level Meter Improved

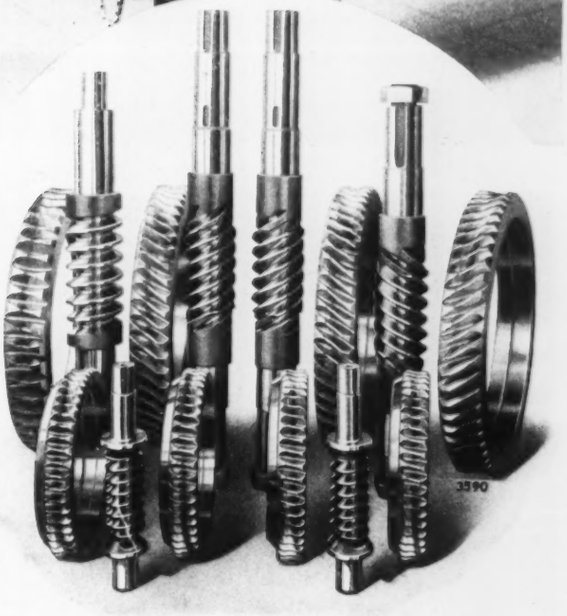
MEETING standard specifications for sound-level meters, an improved Type 759-B meter is announced by General Radio Co., 30 State street, Cambridge Mass. Features are accuracy, rugged construction, convenience in operation and portability. A two-speed indicating meter with selector switch is provided. In the "fast" position of the switch, the meter conforms to ASA specifications. In the "slow" position, the meter is heavily damped and can be used for measuring the average value of rapidly fluctuating sounds. New types of vacuum tubes and batteries give reliable operation



In this linoleum printing machine 32 De Laval Worm Gears are used.

To help your machine sell—

use worm gears



NOISE is bad for humans; tests show that it dulls mental alertness, impairs hearing, increases irritability and interferes with digestion.

Therefore, in designing new machinery, insure quiet transmission by incorporating

DE LAVAL WORM GEAR DRIVES

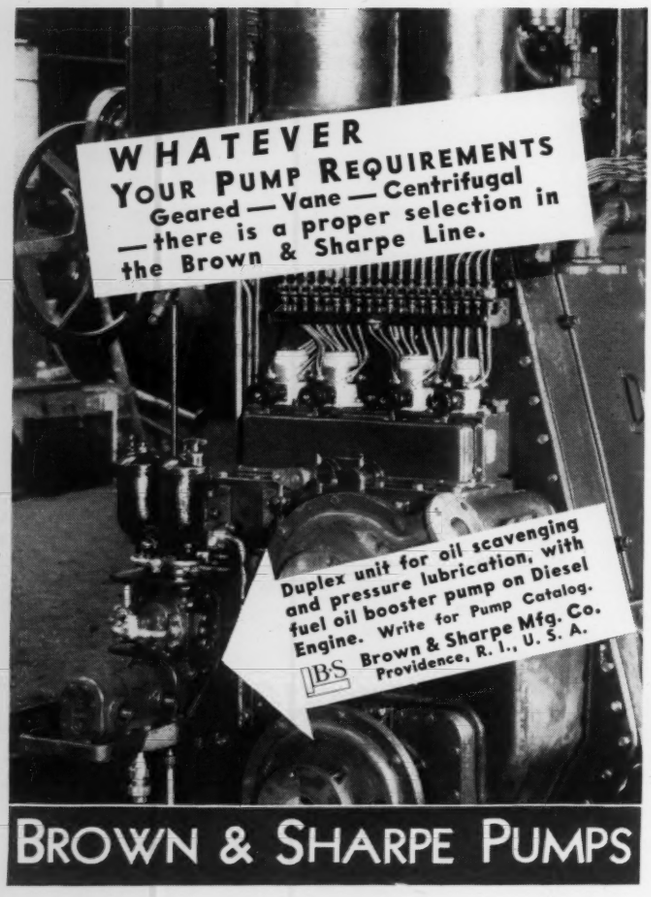
In these gears several teeth are in contact at all times and power is transmitted by a continuous wedging action, giving steady torque and uniform angular velocity and eliminating vibration, pulsation, chatter and the noises that are inseparable from spur gears. The shockless flow of power also prolongs the life of connected machinery and often results in a better product or in increased output from the ability to operate machinery at higher speeds.

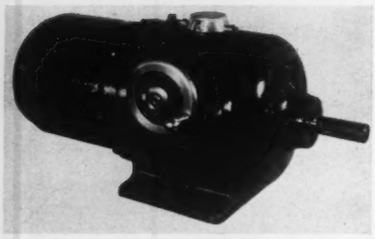
De Laval Worm Gears enhance the reliability of machines in which they are used. They are compact and peculiarly adaptable in application. Our Engineering Department will gladly supply data and advice concerning any proposed use of worm gears upon learning of the conditions and requirements.

Ask for Leaflet E-1175 on "Worm Gears in Industry".

1117

DE LAVAL STEAM TURBINE CO. · TRENTON, N. J.


WHATEVER
YOUR PUMP REQUIREMENTS
Geared — Vane — Centrifugal
— there is a proper selection in
the Brown & Sharpe Line.
Duplex unit for oil scavenging and pressure lubrication, with fuel oil booster pump on Diesel Engine. Write for Pump Catalog.
Brown & Sharpe Mfg. Co.
Providence, R. I., U. S. A.
BS
BROWN & SHARPE PUMPS



The New LENNEY

VARIABLE SPEED TRANSMISSION

is a modern and compact source of power supply, the speeds of which are infinitely and instantly adjustable. A motor of the constant speed, three-phase type, is built integral with the transmission.

Appearance is enhanced by its streamlined design, and compactness of the unit adapts it to applications where limited space is a factor and a built-in drive is desirable.

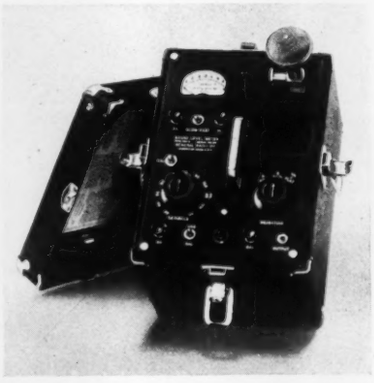
The LENNEY Variable Speed Transmission is quiet in operation and is exceptionally free from vibration. Positive in its drive, the unit is designed to meet the requirements of machinery designers who have problems involving infinite variation of speeds.

This completely redesigned unit is available in sizes from 1/8 to 7 1/2 horsepower inclusive.

Write for illustrated catalog in which full engineering information is given.

THE LENNEY MACHINE & MANUFACTURING CO.
WARREN, OHIO

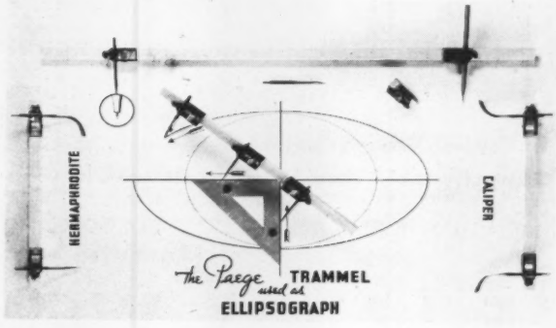
and long life. The entire assembly is mounted in a portable, airplane-luggage type of case. Batteries are self-contained. Range of the meter is 24 to 140 decibels. Provision is made for connecting a General Radio Type 760-A sound analyzer for analyzing the noise spectrum.



Two-speed indicating meter with selector switch is provided on improved sound-level meter

Trammel Draws Parallels to Curves

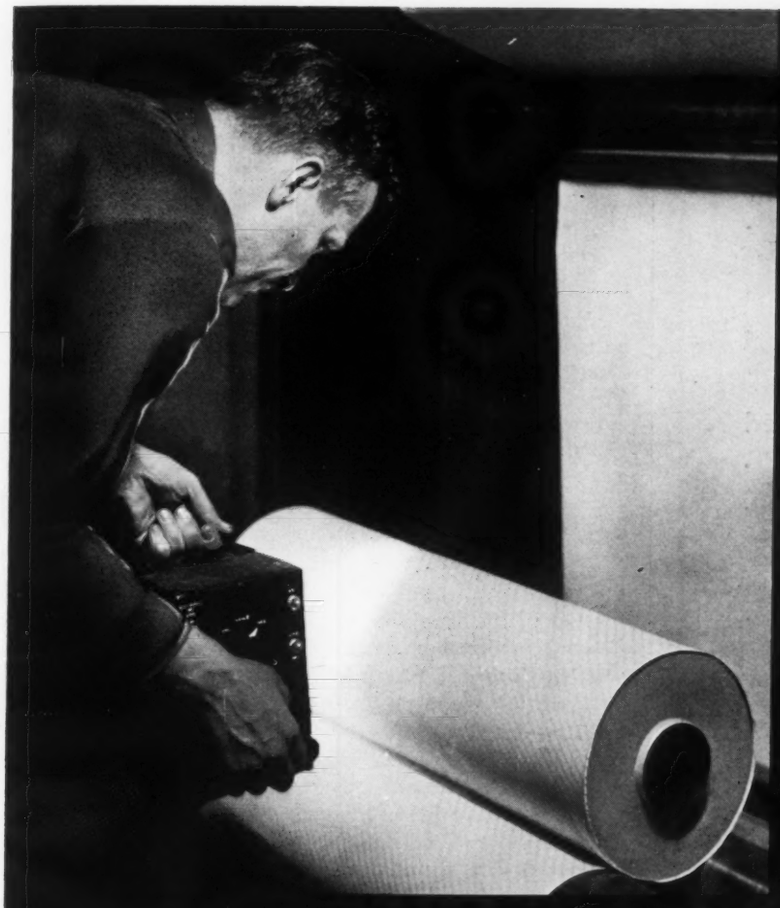
TO DRAW circles and arcs, take measurements, and to draw parallels to curved edges, a new trammel is announced by Reinhold Paege, 14872 Ilene avenue, Detroit. The trammel consists of a 30-inch wooden beam. Two brass bodies with holes in the corners for steel points, knurled brass rollers, nickel-plated and provided with two steel springs, constitute the adjusting mechanism. A third body with holes for common size round or hexagon pencils, is included and two 4-inch long knurled and hardened steel points are furnished. The V-shaped back of the body fits on the back of the beam and is held tight by the spring and the roll on the front of the beam. The V-shape of the beam and body prevents wobbling between these members. No clamp-screws are employed for making adjustments, adjustment being made simply by rolling the knurled rolls with the thumbs. Full view of a drawing is possible during adjustment. The trammel is particularly versatile as an ellipsograph, having the properties of a beam compass, inside and outside caliper, and ellipsograph.



Parallels to curved edges, circles and arcs may be drawn with new trammel, also useful as ellipsograph, having properties of beam compass

Blueprinter Is Announced

PRINTING paper for blueprints, Van Wykes, or for dry or semidry developing processes, the Simplex blueprinter is announced by Wickes Bros., Saginaw,



SPEEDING UP PRODUCTION with the GENERAL RADIO STROBOTAC

Photo courtesy Strathmore Paper Company

THIS SHEET of paper is travelling in a continuous web at 300 feet a minute and is being printed with a design on its surface. When the machine is running, the printed design appears as a mere blur. Since a roll of paper takes as long as three-quarters of a hour to go through the machine, unless the machine is stopped and started many times during the three-quarters of an hour, the operator has no idea of the kind of printing job he is doing.

With the General Radio STROBOTAC, the repetitive design on the paper can be made to "stand still" so that the operator may inspect the pattern and watch the operation of the machine continuously, if desired. Actually, in practice he inspects the paper every three or four minutes, *without stopping the machine.*

The Strathmore Paper Company of West Springfield, Mass. who make extensive use of the STROBOTAC in this operation, is only one of hundreds of users of the STROBOTAC who have found that this useful tool will speed up production, avoid time-consuming and costly delays, by permitting the continuous observation of *any* cyclic revolving or reciprocating motion or machine.

The STROBOTAC will stop motion in any such machine at speeds up to 100,000 rpm. It will effectively slow down machinery, visually, so that the most complex equipment appears to be operating at speeds even as low as a fraction of an rpm!

The STROBOTAC, costing only $95.00, can be operated by anyone, is portable and self-contained, weighs only 12 pounds and operates from any 115-volt 60-cycle line.

Let Us Tell You How The Strobotac Can Help You

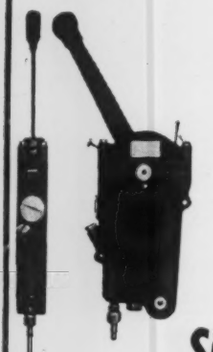
WRITE FOR BULLETIN 594

GENERAL RADIO COMPANY

Cambridge, Massachusetts

BRANCHES: NEW YORK · LOS ANGELES

MANUFACTURERS OF PRECISION ELECTRICAL LABORATORY APPARATUS

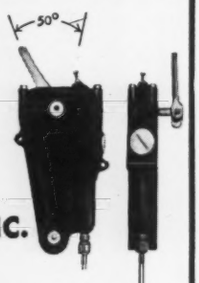


Sperry

HYDRAULIC EXACTOR CONTROL

Single 3/16" Tube Used

The smallest movement transmitted over long distances without backlash. • No creep during vibration. • Airplane design and construction simplified.



Simple... Accurate...

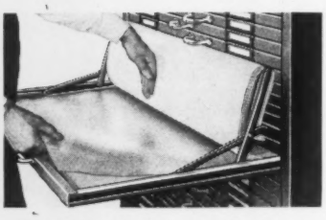
SPERRY PRODUCTS, INC.
HOBOKEN, N. J.

Weight: 5 lbs. 4 ozs. Torque: 110 in. lbs.

SPEEDIER FILING . . .

without tearing sheets

• Filing is faster . . . and safer, too . . . with HAMILTON - CALUMET Shallow Drawer Files. They are equipped with a patented Tracing Lifter. It makes the bottom sheet in the drawer as easy to file as the top sheet. And it eliminates crumpling, tearing, and creasing. Send in the coupon for full information.



The Calumet System eliminates strain when removing the tracing.

HAMILTON MFG. CO.
Two Rivers, Wisc.

HAMILTON Drafting Room FURNITURE

HAMILTON MANUFACTURING CO., Two Rivers, Wis.
Dept. MD-6-40
Send me the complete Hamilton Manual of Drafting Equipment with full information about Calumet Files.

Signed.....

Firm.....

Address.....

City & State.....

Mich. Operating on a small amount of electricity, the machine's vapor-tube light heats in 55 seconds. The unit turns out 250 square feet per hour and requires no carbons or globes. Prints up to 42 inches wide can be made, either in sheets or continuous rolls. Printing speed can be adjusted from 3 to 24 inches per minute. Forced air circulation through the revolving pyrex glass cylinder increases efficiency and life of the vapor tube. Housing finished in black crackle is rigidly built of 20-gage auto-body steel.

Forced air circulation through glass cylinder increases efficiency and life of vapor tube in blueprint machine

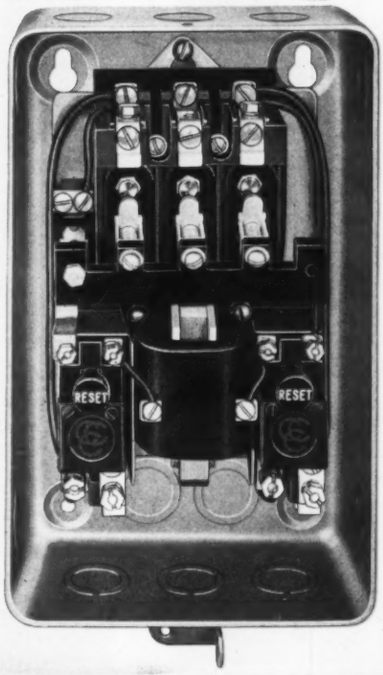
Whiteprinter Uses New Lamp

A QUARTZ envelope high pressure mercury vapor lamp is used in the model A automatic high speed whiteprinting machine announced by the Ozalid Corp., 354 Fourth avenue, New York. This unit provides a printing speed up to 20 linear feet per minute and uniform distribution over the entire printing surface is assured by the lamp, guaranteed for 1000 hours. The machine is available in two sizes for production of prints up to and including 42 and 54-inch widths. An ingenious device automatically separates the print from the original after exposure, the original being returned to the operator at the front and the print being automatically conveyed to the developing unit. After dry development, the print is discharged at the rear of the machine, ready for immediate use. A variable transformer in the primary circuit permits a variation of intensity of the lamp from full brilliancy to 60 per cent of light without loss of energy. The lamp is cooled by an alternating air blast which passes through the space between the revolving contact cylinder and the fixed cylinder surrounding the lamp. By alternating the cooling air stream, high temperatures between the left and right sides of the contact cylinders are avoided.

Automatic high speed whiteprinting machine provides speed up to 20 linear feet per minute

Compact?
Sure! But plenty room for husky fisted maintenance men!

"3C" BULLETIN 6013 • TYPE DS • SIZE O • FORM MA
Across the Line Starter



STARTER GRAM

19___

To A. MOTOROPERATOR

Street and No. PRODUCTION AVE & BUSY ST=

Place ANYWHERE U S A=

NEW SIZE O X-LINE STARTER
PLENTY WIRING SPACE
AGAINST ACCIDENTAL OPERATION
HINGED ARMATURE VERTICAL LIFT MAGNET
BUTTONS PREVENT DESTRUCTIVE ATTEMPTS TO START BEFORE SOLDER HARDENS AFTER
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LARGE ELECTRICAL-MECHANICAL CLEARANCES
LARGE DIAMETER PUSH BUTTONS FULLY PROTECTED
DOUBLE BREAK SILVER TO SILVER CONTACTS
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DESIGNED AND BUILT FOR FREQUENT OPERATING JOGGING AND
WRITE FOR MORE DETAILS=

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VOLTS	MAXIMUM HORSEPOWER 1 PHASE	3 PHASE
110	1	1½
220	1½	2
440	1½	2
550	1½	2

AVAILABLE

With enclosure or open.

With normally open or normally closed control circuit contacts.

In single phase or polyphase types.

In form MA, with overload reset button in cover. Separate pilot device required.

In form MB, with "Manual-Off-Automatic" switch and reset button in cover.

In form MC, with "Start" and "Stop-Reset" button in cover.

In machine tool gray finish on heavy drawn steel enclosure.

With concentric knockouts on top, bottom, sides and back.

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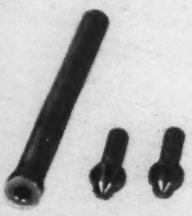
APPROACHES THE DIAMOND IN HARDNESS

KENNAMETAL Inserts Resist Wear
Hold Their Size In Parts Like These

Go and No-Go Gauges
Hold their size many times longer than steel gauges . . . will not rust.



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With KENNAMETAL insert brazed at one end.
Non-galling, wear-resisting.

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Both valve stem and seat are tipped with KENNAMETAL. Lapped so accurately they can hold a vacuum.

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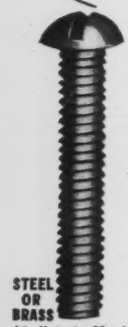

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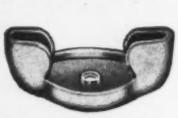

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Microfilm Saves Space

(*Concluded from Page* 59)

order. The bureau operates a photostat machine and after some experiment an attachment was perfected which could be used in place of the conventional lens, through which the small film could be run, and a half-scale image projected directly on photostat paper.

Should a draftsman wish merely to consult a drawing or take off a detail full size, a full-sized image was found to be desirable. This need resulted in the development of a projecting desk—the first of its type—in the accompanying illustration, *Fig.* 1. Depressing a pedal bar turns on the projector light, which switches off when the bar is released. After inserting a reel of film at the back the operator turns a crank at his right

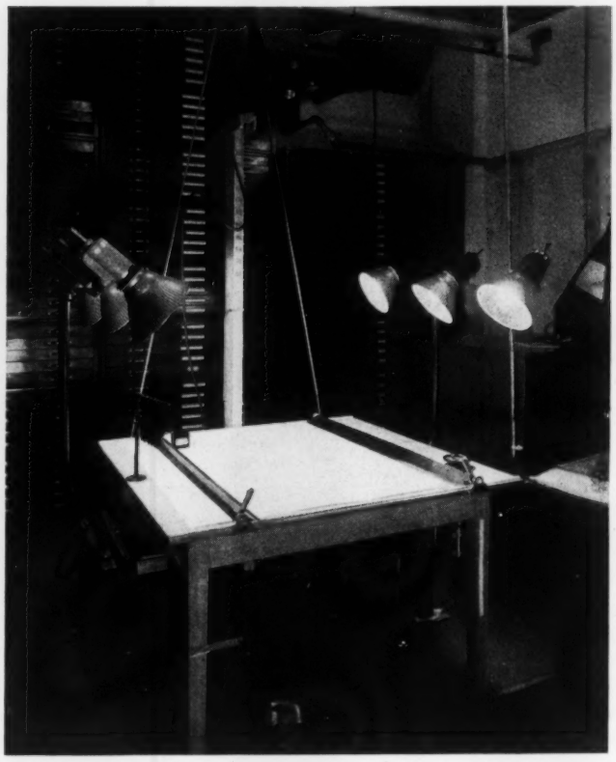

Fig. 2—Arrangement for photographing full size drawings by microfilm method, showing camera above, lights, light meter and table with hold-down strips. Treadle on floor actuates camera shutter and advances film

in the front and advances or rewinds the film until he finds the print he wants.

An image is thrown on a mirror in the bottom of the desk, and from there reflected to the desk surface which is made of clear, tempered plate glass. Placing a screen of thin, translucent plastic material on the glass intercepts the light and shows up the image clearly. For tracing a print or detail the plastic is replaced by tracing paper laid directly on the glass. The smaller bill-of-material sheets are photographed on 16-millimeter film and are viewed through a conventional Recordak library projector.

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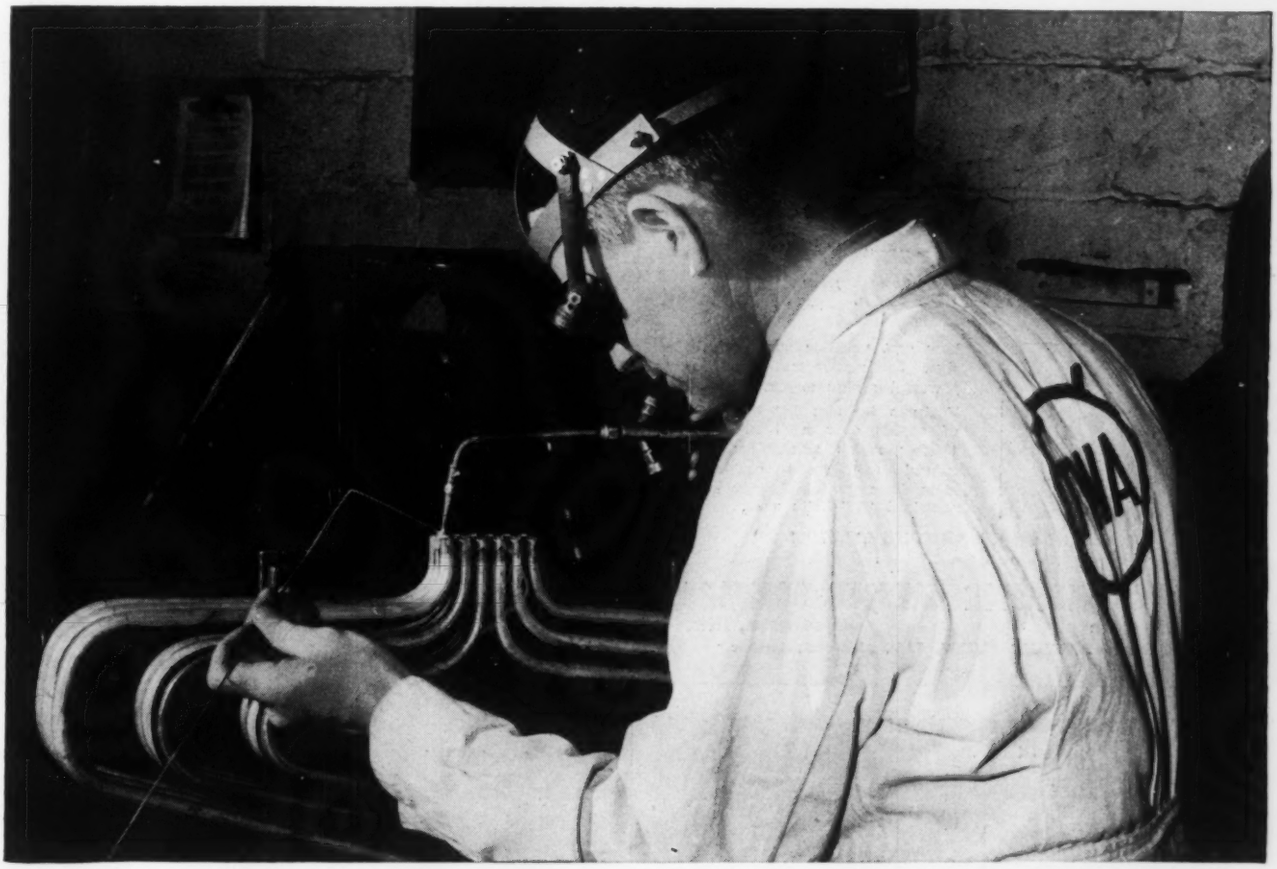
THE SOLUTION: By the AIRCO Oxyacetylene Welding Process



Steam boiler core for cabin-heating system for one of TWA's fleet of thirty-six Douglas Skyliners operating daily and nightly between New York and California. Tubes are being permanently welded by Airco Oxyacetylene Process at company's Kansas City shops.

WITH the advent of high altitude flying, airlines *had* to develop a *dependable* cabin-heating system. They naturally designed one for welding by the Airco Oxyacetylene Process. This welded system proved to be the most efficient yet developed. It heats the cabin more quickly—it is lighter and more compact. » » » This is another progressive step undertaken by the aircraft industry to increase passenger comfort and safety. Others — now accepted as standard — include welded fuselages, engine mounts, landing-gears, exhaust manifolds and seats. Our Applied Engineering Department is available to help you apply the oxyacetylene flame to your individual needs. Write for full details.

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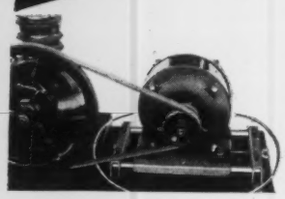

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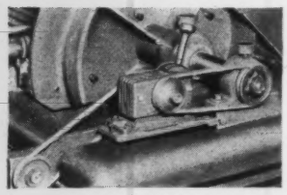

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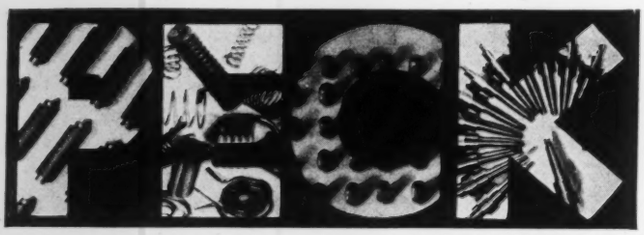

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Basic Principles Applied to Machine Control

(*Concluded from Page* 54)

Fig. 21. The circuit to the *F* contactor is closed by depressing the start pushbutton. When the motor starts to turn, the plugging switch contacts *PS* close. However, the normally closed auxiliary contact on *F* prevents *R* from picking up. When the stop button is depressed the normally-closed auxiliary contact on *F* closes, completing the circuit to the *R* contactor coil, thus plugging the motor. When the plugging switch opens its contacts, the *R* contactor is dropped out.

This circuit has one disadvantage. On some applications it is necessary during setup or adjustment operations for the operator to turn the machine over by hand. This may cause the plugging switch contact to

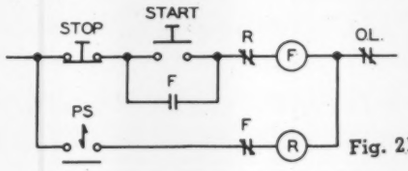

Fig. 21

close with the consequent closing of the reverse contactor. Thus the machine will start in a reverse direction, and injury to the operator may result. This can be eliminated by using one of the newer types of plugging switches equipped with a lock-out arrangement.

Eliminating the objection to this scheme, *Fig.* 22 does not require a lockout type plugging switch. When the start button is depressed, the closing of the auxiliary contact *F* will energize *CR* when the plugging switch contact closes. When the stop button is de-

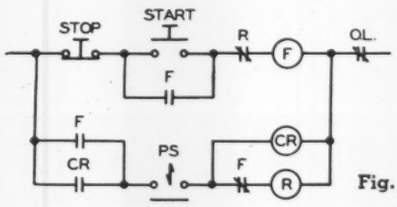

Fig. 22

pressed contactor *R* will be energized through the *CR* contact and the plugging switch. When the plugging switch contacts open both *R* and *CR* will drop out. Since *CR* must be closed before *R* can be energized, closing the plugging switch contacts inadvertently cannot cause the motor to be energized.

These circuits illustrate how various characteristics may be obtained by combining control units in different ways. In this manner it is possible to build up almost any desired sequence and interlock.

Release of a new Industrial Control standard superseding the edition of August, 1937, is announced by the National Electrical Manufacturers association. General standards and definitions are contained.

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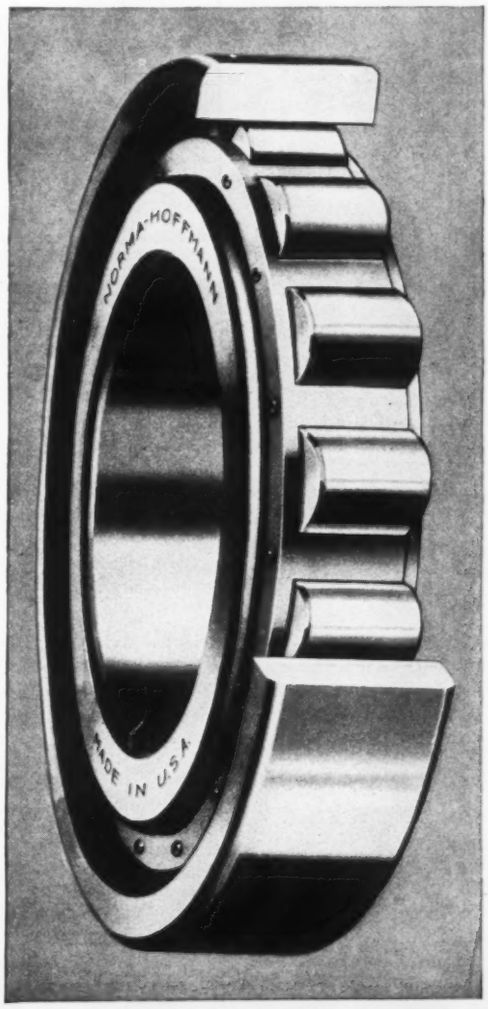

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Development of Business Machine

(*Continued from Page* 41)

a bail to be operated, which will close a contact picking up a master relay that, in turn, causes the machine to stop at the end of that particular card cycle. The closure of this common contact also lights a signal to the operator that there has been a failure to compare between cards. Each latch also acts as an indication of the column in which the failure has occurred. After the card in error has been detected, the operator restores the contact by operating a lever, and the operation of the machine continues. The card which was in error is subsequently removed from the stacker for correction.

Static under certain climatic conditions presents some problems in stacking the cards. Referring to *Fig.* 5, it will be seen that an ejector roll is provided for assurance that the card will be definitely drawn from the feeding rolls into the spring stacker compartment.

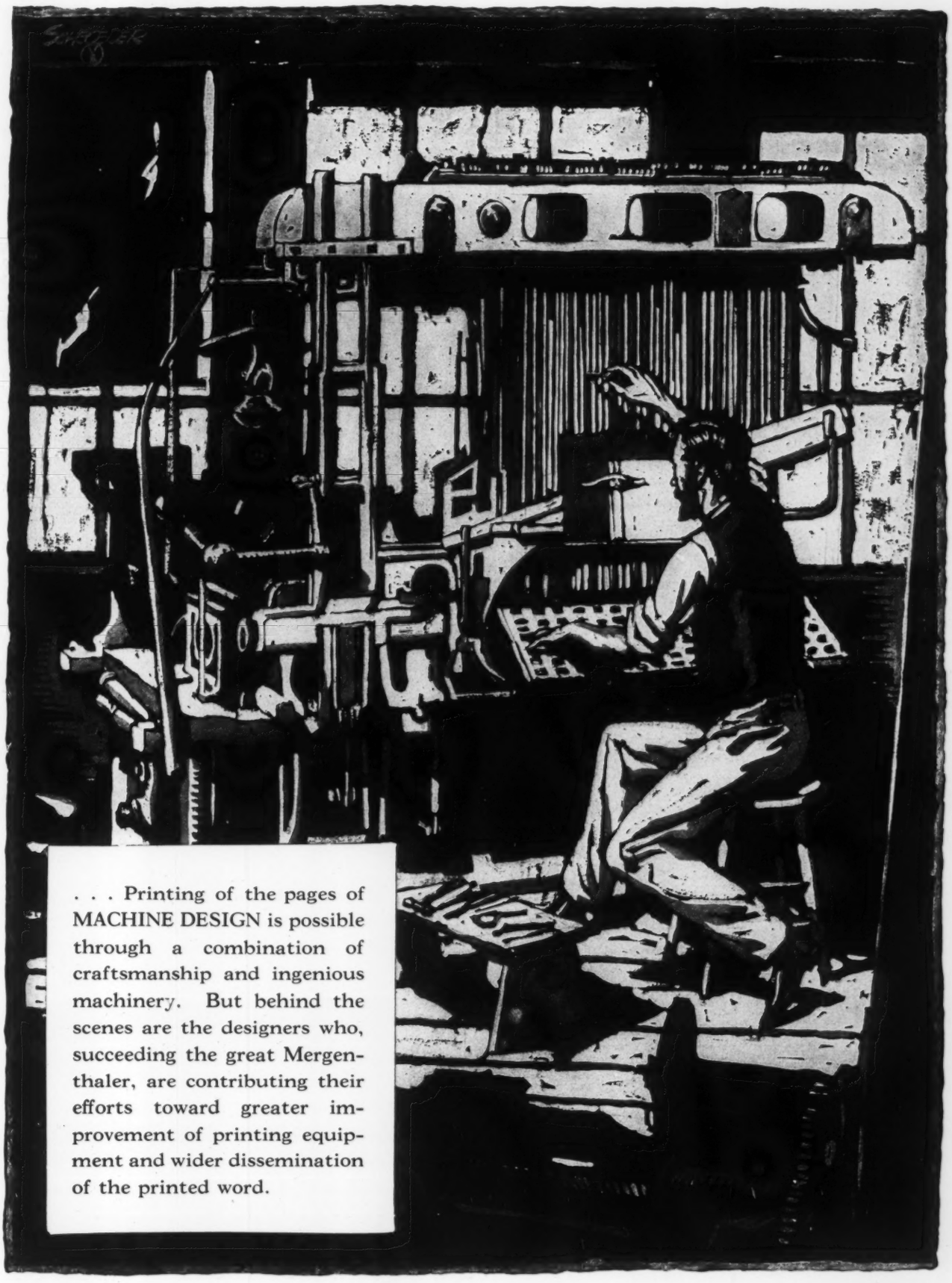
Many materials were tried in the course of developing this roll. Rolls made of abrasive material were satisfactory for the actual stacking and they also showed no wear due to the abrasive quality of the card material. We found, however, that if the machine were left running idle any length of time with cards in the stacker, that the roll would seriously damage the surface of the top card. Several different rubber compounds were tried, and one was finally found that was of the right composition to give a tacky surface suitable for stacking, and yet did not show any perceptible wear because of the card abrasion or cause any injury to cards against which it might run.

Pump Provides Lubrication

At the present time experiments are being conducted with some of the more recent synthetic rubber compounds which appear to offer much better possibilities for use in this stacking operation than the rubber compound, although tests are not complete and production machines are not as yet equipped with rolls made of this material.

Due to the comparatively high-speed operation of the punching mechanism and also the continuous duty to which it is subjected, its lubrication was seriously considered during its development. The principal part of the machine requiring special consideration was the gear housing in which revolves the geneva drive to the feed rolls, the clutch mechanism controlling this device, and also all of the gearing to the feed rolls, stackers, etc.

Two different methods of lubricating were considered, one being to pack the housing with a suitable grease and the other to fill the case partially with oil. When a suitable grease was found tests were



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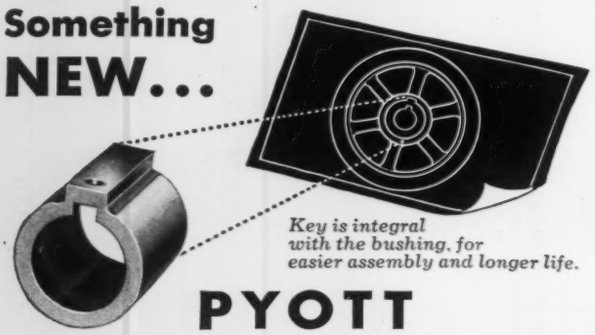

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made with it, but it seemed to have two unsatisfactory characteristics. The gears and geneva drive would cut a path through it after a few operations. After this had occurred, subsequent lubrication was highly unsatisfactory. There was also another reason for changing to some medium other than grease. This was the ability to be able to service the machine quickly.

Oil of the consistency of 30W was tried and offers much better lubricating faculties with none of the objections mentioned above. It was found, however, that when the level of the oil in the case was correct for good lubrication that some difficulty was encountered with oil leakage around the shafts which protruded through the housing. This was particularly true in respect to the feed roll shafts which were driven intermittently by the geneva gear.

Finally a method was adopted to pump oil on to the mechanism by the use of a gear pump inside the case. With this means there is no possibility of leakage due to the oil level, as it can be contained in a depression in the case, below the level of any of the shafts extending through the case. Nor does it have to be drawn out of the case if servicing is necessary. Another important function of this method is that the lubricating oil is much cleaner because of the possibility of its being drawn through a filter in the process of pumping.

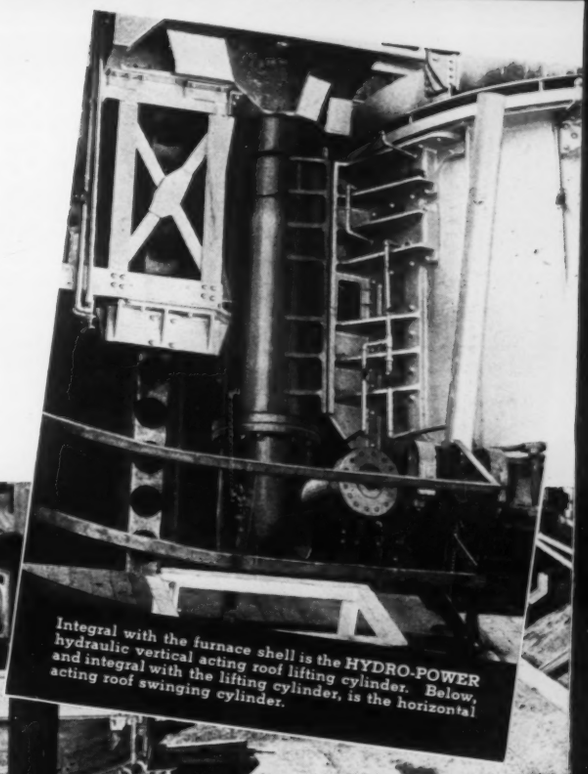
Research Provides Improvements

Although a machine may be completely developed and in public use, the continuation of development and research to improve its operation and decrease its manufacturing cost never stops. An illustration of this is the work that has recently been completed on the construction of the die for punching the holes. The original construction provided for making the 80 rectangular holes in the die by milling a slot equal in width to the length of the hole, then milling 81 slots across this long slot on the same side, which were equal to the spacing between the holes. Separators were then inserted in these 81 slots and staked in position. The surface of the die was then ground to provide for a surface that was flat and smooth to allow the easy passage of the edge of a card by it. Each of the 80 holes then had to be broached to fit the punches that would finally be used.

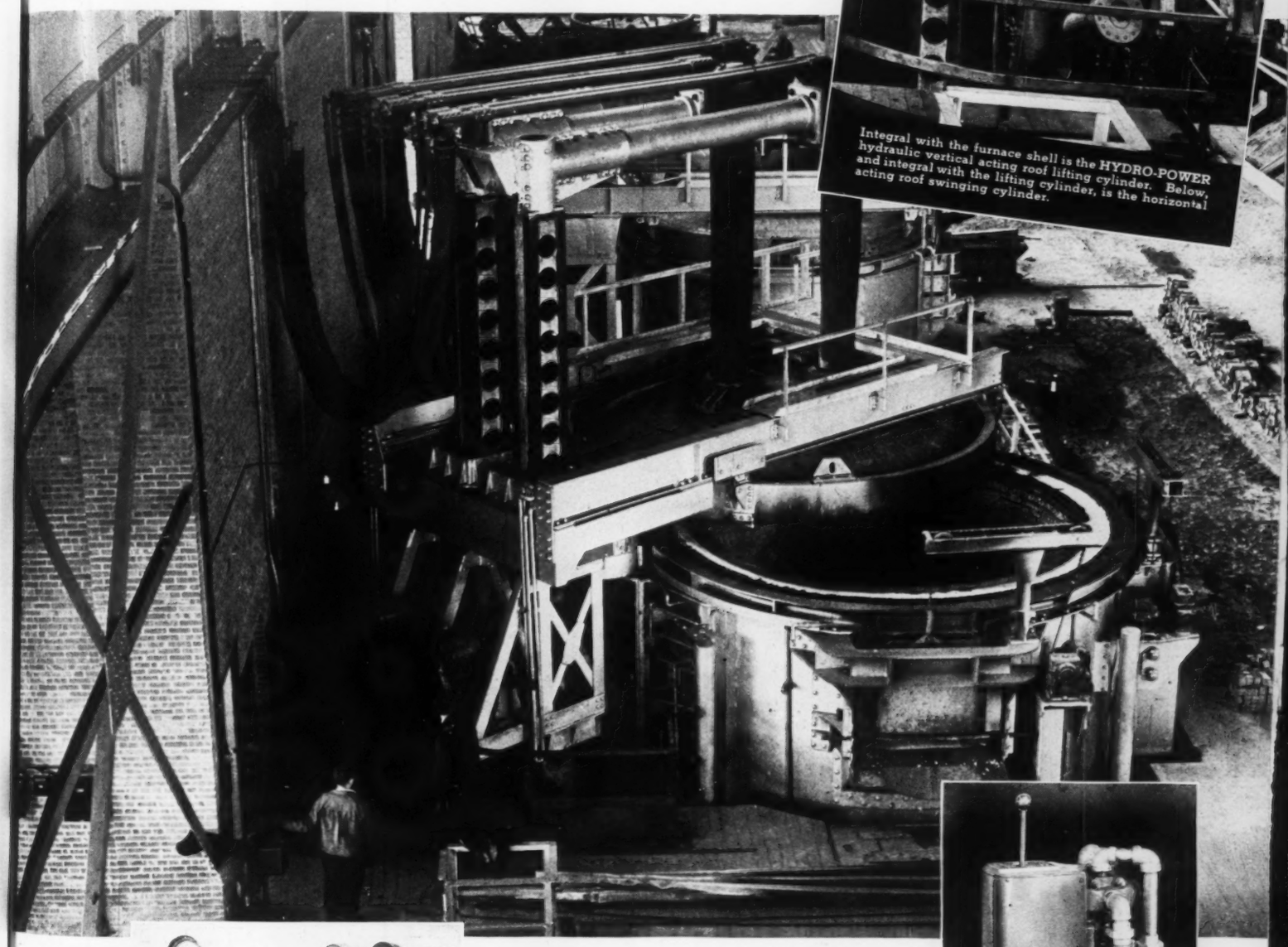
Construction of the stripper and punch guide was somewhat similar to the die except there were 80 slots milled across the long slot on the opposite side. The depth of these 80 slots was such that they broke through the bottom of the long slot, thus forming 80 rectangular holes.

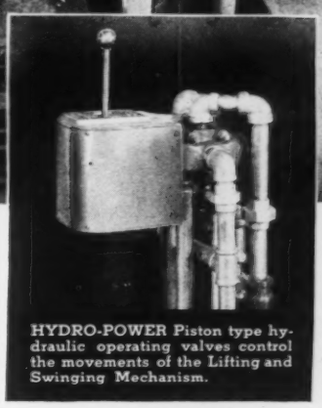
Present die and stripper is fabricated by punching the rectangular holes in a sheet of thin spring steel, which is fastened by riveting to a heavy bar to supply strength. The spring temper of the stock sup-

HYDRO-POWER LIFTS and SWINGS The Roofs of the World's Largest Swinging Roof Type Electric Furnaces in the New Copperweld Plant

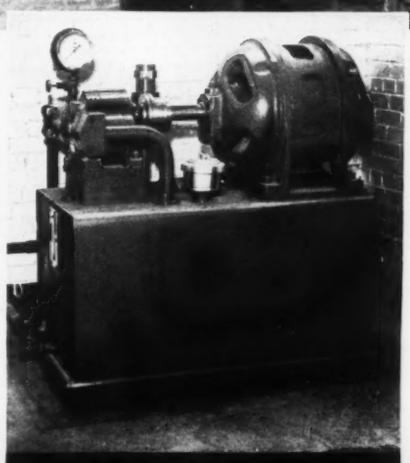


Integral with the furnace shell is the HYDRO-POWER hydraulic vertical acting roof lifting cylinder. Below, and integral with the lifting cylinder, is the horizontal acting roof swinging cylinder.





HYDRO-POWER Piston type hydraulic operating valves control the movements of the Lifting and Swinging Mechanism.



A standard HYDRO-POWER heavy duty Gear Pump power unit supplies moderate hydraulic pressure to actuate the roof lifting and swinging movements.

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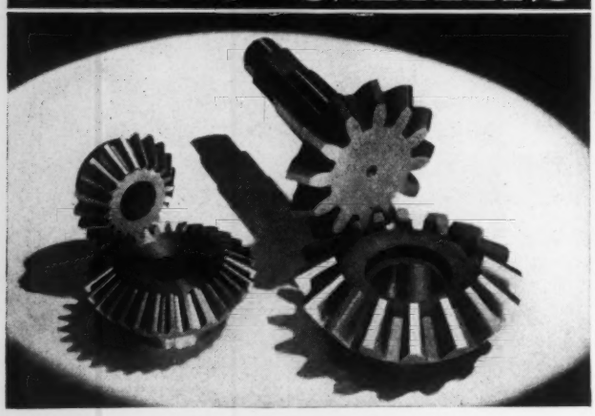

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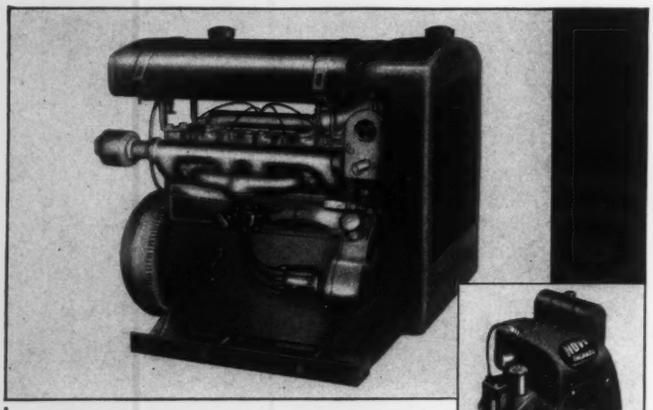

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plies a good cutting edge and also gives a long wearing die. This construction also provides for using the same parts for the stripper and guide as are used in the die proper. With this improvement, if any injury does occur to the die, it is a comparatively simple matter to correct, and also a substantial saving in manufacturing cost is effected.

All of the control keys, switches, card hoppers, and stackers are conveniently arranged at the front of the machine, so that all the manual work that is necessary can be done without the operator moving from in front of the machine. This is an item of much consequence in insuring that the production of the machine, which was considered throughout all of its design stages, will not be decreased.

The finish of the covers, base, and legs on the machine is a fine grain black crinkled enamel. This, in comparison to the polished chrome-plated parts adjacent to these parts, provides a pleasing appearance to the machine.

Silver Alloy Brazing

(*Concluded from Page* 66)

boiler having 1237 copper tubes joined to mild steel headers 48 inches in diameter and ¾-inch thick. Brazing was done with a silver alloy melting at 1175 degrees Fahr. and under test this boiler was fired to 225 pounds pressure, steam and water blown out and cold water immediately pumped into the dry hot boiler. Repeated firing and cooling showed no failure in the brazed joints. Similar tests on assemblies of heavy wall copper tubing and fittings brazed with an alloy melting at 1300 degrees Fahr., showed no failure when subjected to a steam pressure of 200 pounds per square inch and followed by the introduction of cold water for many repeated cycles.

Silver brazing alloys are used in considerable quantities for the manufacture of chemical equipment, dairy and creamery equipment and in plants and equipment for the dye industry. There are innumerable applications in the electrical, automotive and airplane industries where instruments, oil filters, oil coolers, gear shift levers, steering wheel spiders, contact joints, window frames, oil lines and radiator grilles are being brazed with these low melting silver alloys.

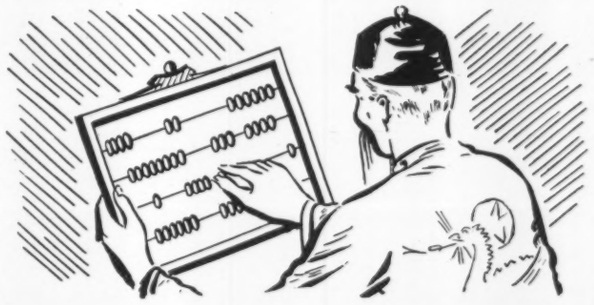
There is a suitable silver brazing alloy available for making practically every type of joint on nearly all metals and alloys that melt at temperatures above 1250 degrees Fahr. As engineers become better acquainted with the strong neat joints that can be made quickly and economically with these alloys, at comparatively low temperatures, their use is being extended rapidly into all industrial fields and they provide an effective means of meeting many of the problems in the manufacture of modern equipment.

THE WHOLE STORY
IN A NUTSHELL

Ward Leonard Rheostats cover a range from the small types for fractional horsepower motors to the largest multiple units to control the heavy current requirements of rolling mills. The Bulletins covering the types, drives, mountings and accessories of the Ward Leonard Line is the whole story of Rheostats "complete in a nutshell".

Send for Rheostat data bulletins.

WARD LEONARD
ELECTRIC COMPANY
45 SOUTH STREET MOUNT VERNON, N. Y.
ELECTRIC CONTROL DEVICES SINCE 1892



Ancient China had the Abacus

Industry Today has
PRODUCTIMETERS
THE SPEEDOMETERS OF INDUSTRY
REG. U.S. PAT. OFF.

Today, DURANT PRODUCTIMETERS are used by industry for all its counting and measuring problems. Machine designers are becoming more and more interested in Productimeters and their applications as standard equipment on new manufacturing units. Different models are available for all industrial uses. Durant counters are ideal for vernier reset indicators on press brakes.

WRITE US FOR COMPLETE DETAILS TODAY!

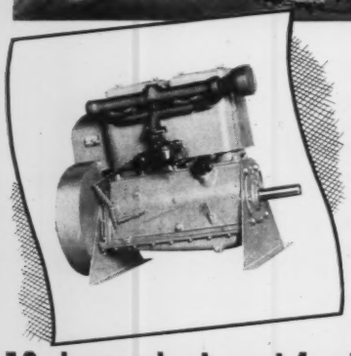
DURANT MANUFACTURING CO.
1933 N. Buffum Street, Milwaukee, Wisconsin

SOLVED THE G-E WAY

PART: Textolite Molded Typewriter Top Cover. **USE OF PART:** Used on noiseless typewriter manufactured by Remington Rand, Inc. **CUSTOMER'S PROBLEM:** Remington Rand, Inc. wanted a material to replace metal that would be lightweight, stable, and tough with a high gloss finish. Dimensional accuracy was essential. **SOLVED THE G-E WAY:** The selection of Textolite as the molding material was the final solution of most of the customer's requirements. Use of Textolite provided a lightweight product with good stability and toughness. It meant a product with a highly lustrous finish. But in addition to satisfying customer specifications, Textolite—an insulator against vibration—also possessed an acoustical advantage for the noiseless typewriter. In the molding section, special gauges with revolving parts were designed for a working check of the part, thus providing a product with permanent mechanical rigidity and completing THE G-E WAY of giving Remington Rand, Inc. a better product at reduced cost. No matter what the application may be, you will find a Textolite material, special molding facilities, and a competent staff of G-E engineers ready to help solve your molding problem. For further information and recommendations, write Section E-60, Plastics Department, General Electric Company, One Plastics Ave., Pittsfield, Mass.

PD-301

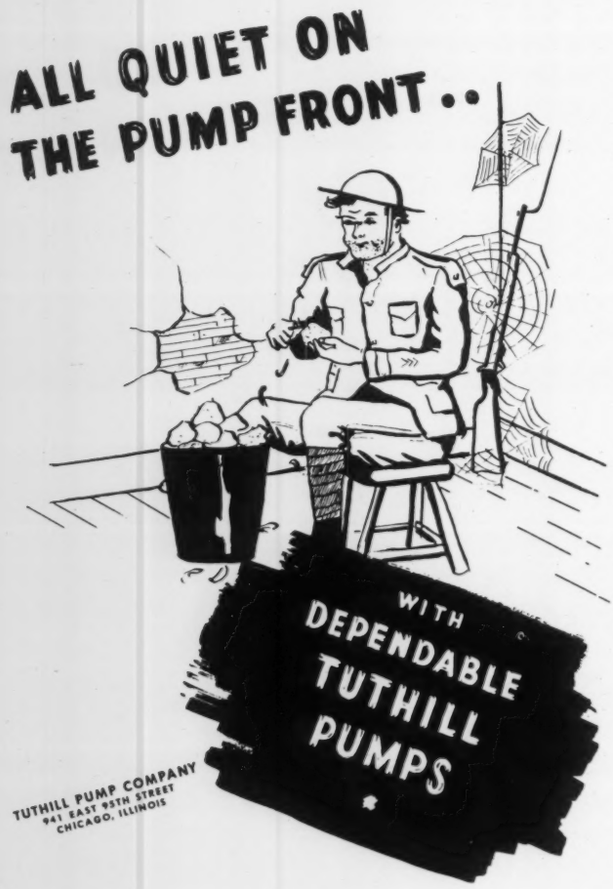
GENERAL ELECTRIC



Want to safeguard your machine against engine trouble in any kind of weather? Then do as *290* other leading equipment manufacturers do—use WISCONSIN air-cooled power. It is safe — economical — the best power buy.

12 sizes • single and 4 cylinder • 1 to 35 H.P.

Wisconsin Motor Corporation
MILWAUKEE, WISCONSIN, U.S.A.



Business and Sales Briefs

OPENING of a new branch office to serve the Southwest is announced by Morse Chain Co. at 1418 Polk street, Houston, Tex. Manager will be Bob Koch, who has been assistant sales manager at Ithaca, N. Y., for the past five years. The branch opened May 1 and will carry complete stocks of the Morse line of power transmission parts.

♦

Changes in representation in the southeastern section are announced by Foote Bros. Gear & Machine Corp. Continental Gin Co., Industrial division, Birmingham, Ala., will be representative in the following localities: Alabama, Georgia, South Carolina, North Carolina, Florida and the southern portion of Mississippi. Northern Mississippi will be covered by the company's regular representative, Eugene D. Wilson.

♦

Construction work on the new $50,000 addition for the plastics department of General Electric Co., Pittsfield, Mass., is expected to be completed June 15. The structure will house activities for development of new plastics on a small scale production basis and will comprise 6000 square feet of floor space suitable for manufacture and an equal amount for warehouse facilities. G. H. Shill is manager.

♦

With Wilson K. Winbigler in charge, a branch office in the Hearst Tower building, Baltimore, has been opened by Ward Leonard Electric Co., Mount Vernon, N. Y.

♦

G. E. Hunt has been appointed head of the Indianapolis office, 307 North Pennsylvania avenue, of Cutler-Hammer Inc. This office is under the direct supervision of C. J. Maloney, manager of the Chicago district sales territory. Since joining Cutler-Hammer in 1920, Mr. Hunt has served in the New York, Philadelphia, Milwaukee and Cleveland sales offices and is well qualified to serve the company's customers in the rapidly growing central Indiana area.

♦

Appointment of George C. Miller as sales manager of the Plastics division, Carbide and Carbon Chemicals Corp., is announced. Associated with the company's plastics activities since the early commercial development of Vinylite resins, Mr. Miller is familiar with all phases of the business and well equipped to render full service.

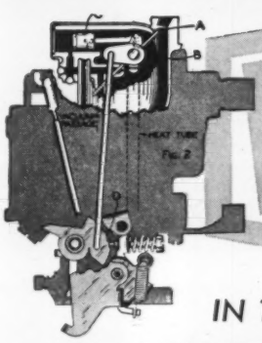
♦

Purchase of a three-story plant at 8344 Frankstown avenue, Pittsburgh, is announced by the Gibson Electric Co., manufacturers of Gibsiloy electrical contacts. The plant was occupied May 1 and modern equipment will be installed to give the company complete control of its manufacturing processes and to increase production capacity greatly.

♦

Transfer of R. F. Heath from the Houston territory to the New Orleans territory, formerly covered by Jack Schuyler, is announced by Manning, Maxwell & Moore

LEADERSHIP!



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It's STROMBERG CARBURETORS *using* WILCO THERMOMETAL

Accuracy and dependability are the keynotes of the new Stromberg "Automatic choke control" carburetor you'll find in the 1940 Buicks. *Naturally,* the important thermostatic bi-metals are by Wilco —supplier of such metals to the industrial leaders of the world for more than 26 years.

Pioneers in the development, manufacture and sale of thermostatic bi-metals, Wilco's experienced research technicians *welcome* new problems. Why not consult them about *yours?* The H. A. Wilson Co., 105 Chestnut St., Newark, N. J. Br. Offices: Detroit, Mich., & Chicago, Ill.

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(Thermostatic Bi-Metal)

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By Dr. A. M. Wahl

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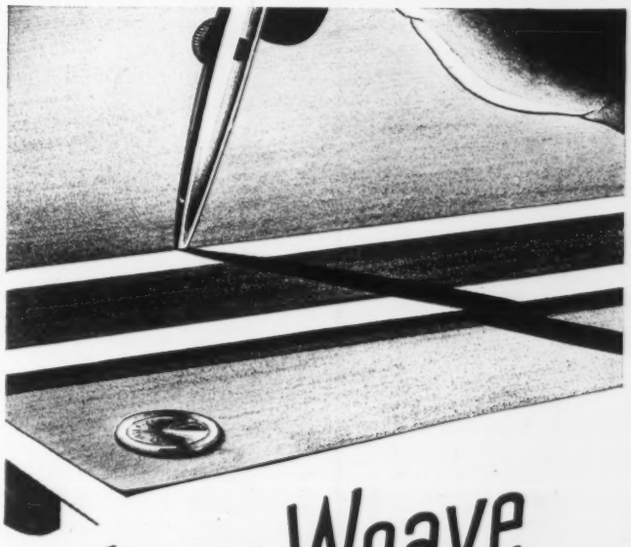

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THE HOLLISTON MILLS, Inc., Norwood, Mass.
Companion Products: Royal Blue Print Cloth and Photo Cloth.
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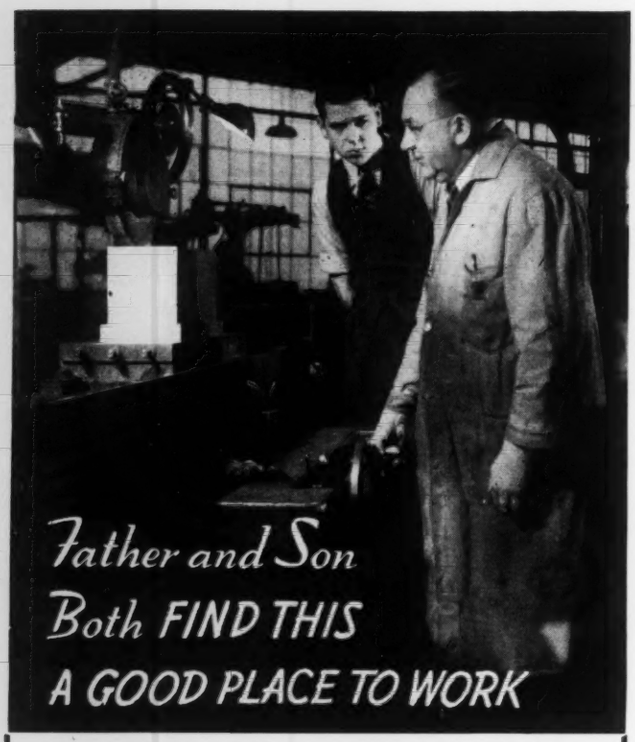
ST. LOUIS · RICHMOND

The dispensing roll container is a protection, a convenience and an identification. It keeps the cloth clean — handy brackets attach to desk or table.



Just as Carl Levin Senior and Junior find this an ideal place to work, so will you find this an ideal place to bring your plastic molding problems.

Compression and injection molds and molding.

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IF YOU WANT GOOD LUCK

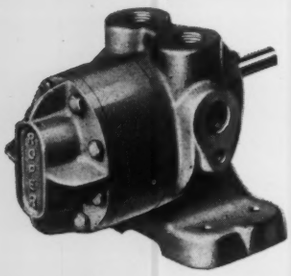
with your Pumping Problems

Installing Roper Rotary Pumps is like finding a horse-shoe . . . because Ropers always bring what some users call good luck.

Of course, with Roper Pumps it is not luck, really, because they are built to serve with the highest degree of efficiency that can be built into a pump.

This is especially true of the new improved line of Roper Hydraulically Balanced Pumps.

We would like to send you our latest catalog, No. 932, which illustrates and describes the new Roper line and also gives valuable pumping data. Write for your copy today.



HYDRAULICALLY BALANCED

ROPER
Rotary **PUMPS**
DEPENDABLE SINCE 1857

GEO. D. ROPER CORP., ROCKFORD, ILL.

Inc. Mr. Heath is well-known in New Orleans where he was located before going to Houston.

♦

The newly-created position of assistant sales manager of the accessory division, Stewart-Warner Corp., will be filled by Ernest N. Robinson who has been with the company for the last six years.

♦

Sales of General Electric conduit products will be handled by Don J. Murray, newly appointed sales manager. His headquarters will be at Bridgeport, Conn.

♦

New district office of Century Electric Co. in Chicago is the Igoe building, 600 West Van Buren street. H. A. Porter is regional sales manager, H. L. Madsen district sales manager.

♦

Doubling the capacity of the new metal producing plant under construction at Vancouver, Wash., is permitted following an additional contract between Aluminum Co. of America and the Bonneville Power administrator. Annual capacity of the plant will now be 60,000,000 pounds. New contract is limited to five years.

♦

Approximately $132,000 will be spent by The International Nickel Co., for physical improvements at its Huntington, W. Va., plant. Program calls for expenditure of $63,000 in the cold draw department, where an additional car-type electric heat treating furnace and other equipment will be installed, and $69,000 for erection of a brick building doubling chemical and physical laboratories. The new building will permit concentration under one roof of metallurgical and physical testing equipment as well as technical personnel.

♦

Construction of a substantial plant addition and new office quarters for Vickers Inc., is to be launched immediately, adjacent to the company's existing plant at 1400 Oakman boulevard, Detroit. Increased demand for hydraulic controls and other equipment used by aircraft and machine tool industries is responsible for the expansion.

♦

Appointment of William Taggart as manager of tube sales is announced by Timken Roller Bearing Co., Canton, O. Mr. Taggart has been associated with the Steel and Tube division of Timken since June 1928.

♦

Formerly manager of the apparatus research and development department of Air Reduction Co., John J. Crowe has been appointed assistant to Herman Van Fleet, vice president and operating manager. Activities of the apparatus research and development department will be directed by Mr. Crowe, as well as those for Wilson Welder & Metals Co. Inc. In addition he will handle apparatus patent matters for Mr. Van Fleet. H. E. Landis Jr., formerly assistant to Mr. Crowe, has become manager of the apparatus research and development department.

♦

A new representative for the worm gear division of De Laval Steam Turbine Co., Trenton, N. J., has been announced. This is The J-B Sales Engineering Co., New Haven, Conn. The addition of Frank Griesing to the company's staff has been made.

♦

Jay Irwin has been made Chicago district manager of the Steel and Tube division of The Timken Roller

BRING YOUR GASKET TROUBLES TO US

Ordinary gaskets, pump packing and other sealing materials are frequently the "weak links" in the production of corrosives, chemicals, oils and liquids. Many chemical manufacturers have discovered the *best possible* protection for such VITAL ZONES is obtained with FEL-PRO products. FEL-PRO metallic or fibrous packings furnish such *extra service* under the most rigorous conditions.

FEL-PRO METALLIC PACKING

FEL-PRO flexible metallic packing is furnished in standard and special styles for many applications in industrial and marine fields. Individual strands are formed by the longitudinal folding of foils. Metallic strands furnished either cored or uncored. Basic metals used are lead, aluminum or copper.

BUT FEL-PRO *extra service* is not confined to the product itself! FEL-PRO engineers are at your service to help you select the best obtainable material to fully satisfy the requirements of your *particular* production requirement. No matter how limited your needs, FEL-PRO engineers will be glad to work with you in providing the proper packing that will furnish *extra service* life and durability.

FELT PRODUCTS MFG. CO.
1517 W. Carroll Ave., Chicago, Ill.

FEL-PRO Gaskets
METALLIC PACKING

MAIL THIS COUPON!

FOR FREE SAMPLES OF BRISTO SOCKET SCREWS

SEE FOR YOURSELF THAT BRISTOS MEAN EASIER, FASTER, TIGHTER SET-UPS EVERY TIME!

This coupon is sitting on top of the page because it contains an important invitation that you will not want to pass up.

EXTRA STRENGTH FOR EXTRA SAVINGS

Put these husky Bristo Socket Screws through their paces, —on your machines or in your products. Note their ease of handling, holding power, ability to withstand the assaults of the wrench where operations demand repeated removal and resetting. You will soon realize why so many manufacturers agree that a Bristo's easier, faster, tighter set-up saves assembly time, abolishes waste motion, helps lower production costs,— benefits you want to enjoy.

QUICK BRISTO FACTS

Lock-tight socket head,—won't split, shear, round out, jam or strip. Set tighter with less effort. No loosening under vibration. Take wrench without fumbling or skidding.

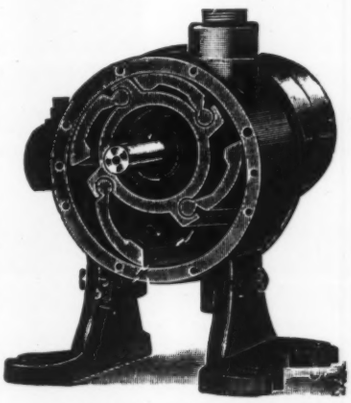
MAIL COUPON TODAY

Learn what these superior screws can do for *you*. The Bristol Company, Mill Supply Division, Waterbury, Conn.

BRISTO SOCKET SCREWS

The Machine Designers Favorite Air Pump

Favorite because of its numerous sizes, its simple lines of construction, but above all because of its reliability—its positive performance which—just because it is so simple in design—can never fail to give its best.



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Rotary Positive
AIR PUMPS
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They Take Up Their Own Wear

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LEIMAN BROS.

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Makers of Good Machinery for 50 Years

Bearing Co. Since October, 1937, Mr. Irwin has been a salesman in the Chicago branch office of the Steel and Tube division.

♦

Appointment of E. L. Parsons as sales manager of Winfield H. Smith Inc., Springville, Erie county, N. Y., is announced. His wide experience in the transmission field makes him well equipped for directing sales of WHS speed reducers.

♦

Formerly manager of tube sales for Timken, David Marvel has joined National Tube Co. as assistant manager of sales of the Ellwood sales division, Ellwood City, Pa.

♦

An expansion of its present plant is being planned by Bundy Tubing Co., 10951 Hern avenue, Detroit.

♦

Benjamin T. Moffatt has been named New York district manager for Hewitt Rubber Corp., Buffalo. Headquarters will be in New York.

♦

D. S. Kerr, who has served as salesman in various of the Allis-Chalmers Mfg. Co. southern offices as well as manager of the Chattanooga, Tenn., office, has been appointed manager of the Atlanta sales office of the company. Both the Chattanooga and Knoxville, Tenn., offices will be under Mr. Kerr's jurisdiction.

♦

With headquarters at Akron, O., H. D. Tompkins has been appointed sales manager of Firestone Tire & Rubber Co. C. M. Barnes will succeed Mr. Tompkins as sales manager of Firestone California.

♦

Huie-Simmer Co., 103 Thomas building, Dallas, Texas, has been appointed district sales representative of Trico Fuse Mfg. Co., Milwaukee, in the state of Oklahoma. Another appointment made by the company is that of L. W. Sloan, 408 Olive street, St. Louis, as district representative in St. Louis and vicinity.

♦

John G. Bell has joined the Cleveland sales department of Jones & Laughlin Steel Corp., Pittsburgh. Mr. Bell was formerly connected with Youngstown Sheet & Tube Co.

♦

Since 1933 sales manager of the conveyor division of Chain Belt Co., Milwaukee, L. C. McKnight has been named assistant to the vice president.

♦

Directors of Udylite Corp., Detroit, recently elected Lawrence V. Nagle vice president and re-elected other officials. A graduate of University of Detroit, Mr. Nagle joined Udylite in 1932 after association with several other firms, and in 1937 was appointed district sales manager of the Detroit area. He will continue his latter duties. The Udylite Corp. also announces removal of its eastern district office to 60 East Forty-second street, New York, from 30 East Forty-Second street. A. B. Hoefer is eastern district manager.

♦

Crucible Steel Co. of America has appointed David K. Miller manager of the Baltimore branch. Since 1937 Mr. Miller has been district representative at Baltimore until its recent designation as a branch office. The company has also made other appointments which are that of J. S. Billingsley as assistant manager of the Pittsburgh branch, and George Sharpe, formerly associated with Michigan Tool Co., specializing in sales and promotion of Rexalloy.

A CLEAN SWEEP

with clean-running BCA Ball Bearings

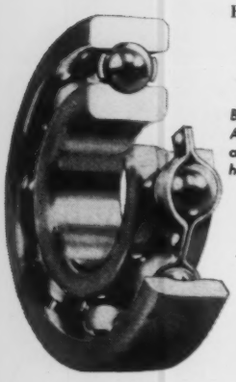
DAY-IN, DAY-OUT operation of the Patrol Sweeper demands accurate, free-running ball bearings at every essential point to relieve both machine and operator from fatigue.

The many sizes and styles of BCA Ball Bearings which go into this and other Austin-Western machines are selected after rigid tests to function perfectly in each application.

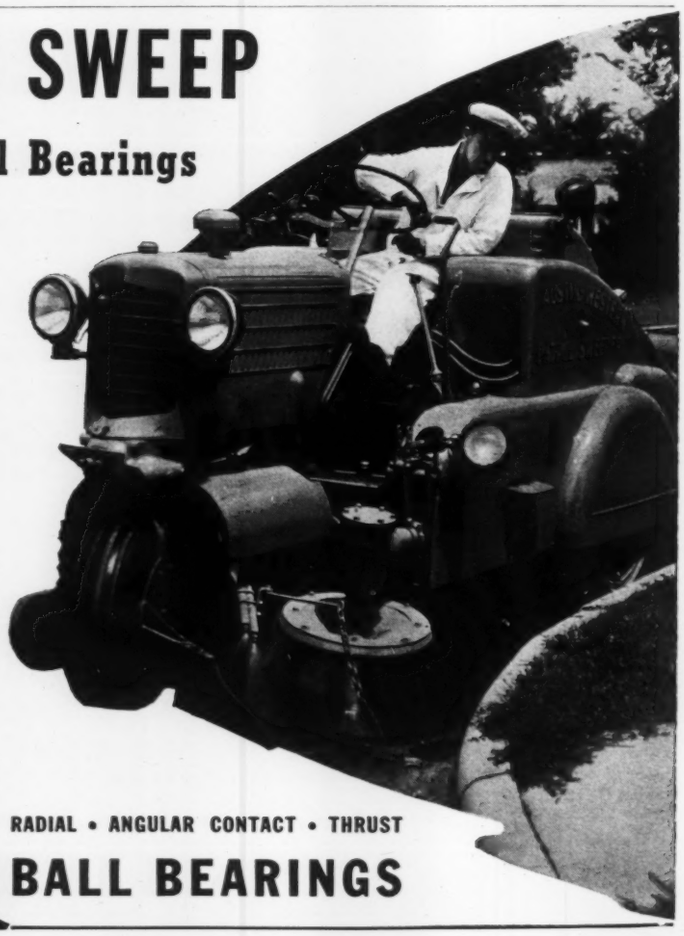
BCA welcomes this sort of buying—likes to work with and for progressive manufacturers in helping to find the most efficient bearing for each job.

If you, too, would like to buy bearings on this basis, perhaps we can do business together.

BEARINGS COMPANY OF AMERICA
LANCASTER, PENNA.



Built to meet the needs of modern cities, this Austin-Western Patrol Sweeper is a striking example of modern design which breaks away from hide-bound tradition to do a more efficient job.



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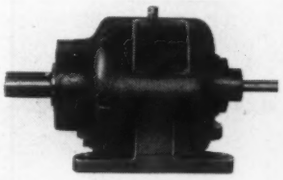
Be sure to have it on hand for ready reference. It lists . . . . illustrates . . . . gives detailed specifications of . . . . *largest complete line* of speed reducers available from any one source. Includes Single Worm, Double Worm, Spiral, Spiral and Worm, Spur, Horizontal, Vertical, Two-Speed and Differential.

WHS

SPEED REDUCERS

WHS expert engineering service (no obligation) . . . . WHS low prices . . . . and WHS prompt shipments are *established advantages* of dealing with us. And new Catalog No. 140 is yours for the asking.



No. 7 WHS Differential Speed Reducer

WINFIELD H. SMITH, Inc.

A Speed Reducer for Every Application

16 ELTON STREET, SPRINGVILLE, ERIE COUNTY, N. Y.

Established 1901

LUBRICATED FOR LIFE
The machine tool market asks for more pieces per hour. The machine tool asks for higher speed and more automatic control. The machine designer asks for ideas.
Let us help. Our engineers are ready to show you how Pulsolator can automatically lubricate your machines for life.
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Lathe & Grinder Inc.
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Automatic Oil Lubrication
BLANCHARD PULSOLATOR

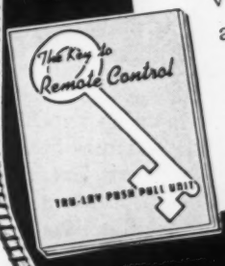
Operators are More EFFICIENT *Machines* are More PRODUCTIVE

with **TRU·LAY PUSH-PULL CONTROLS**

● Operators work with more confidence and efficiency when their machines respond more readily to controls that may be operated at most convenient points.

TRU·LAY Push-Pull Controls are alert and positive in operation. They hold any position to which they are set. There is none of the noise, sloppiness, uncertainty and bother that come with rods, links, bell-cranks, pins and other devices. **Push-Pulls** require no adjustment.

They are easily installed, because they are quickly snaked around any obstructions.



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Please send complete information on TRU-LAY PUSH-PULL CONTROLS.

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Address .....

City ..... *State* .....

NEW MACHINES—
And the Companies Behind Them

(For illustrations of other outstanding machinery see Pages 62-63)

Bottling
*Automatic liquid filler, Horix Mfg. Co., Pittsburgh.

Domestic
*Vacuum Cleaner, Westinghouse Electric & Mfg. Co., East Pittsburgh.

Commercial
*Rug beater, United Vacuum Appliance Corp., Connersville, Ind.

Construction
Hydraulically operated scrapers, Gar Wood Industries Inc., Detroit.
Hydraulic scraper, Bucyrus-Erie Co., South Milwaukee.
Crawler tractor, Allis-Chalmers Mfg. Co., Milwaukee.

Industrial
*Gas engine, Bruce-Macbeth Engine Co., Cleveland.
*Oxygen generating device, Ray-O-Zone Products Corp., Chicago.

Maintenance
*Street sweeper, Gutter Snipe, Municipal Supply Co., South Bend, Ind.
Tractor sweeper, Frank G. Hough Co., Libertyville, Ill.
Utility spray tank, Littleford Bros., Cincinnati.

Materials Handling
Sheet handling truck, Lyon Iron Works, Greene, N. Y.
Motor truck scales, Toledo Scale Co., Toledo, O.

Metalworking
Metal rolling machine, Mercury Machinery Co. Inc., Chicago.
Hot and cold rolling mill, Farrel-Birmingham Co. Inc., Ansonia, Conn.
Grinder, Stanley Electric Tool Div., New Britain, Conn.
Air-operated riveting hammer, Ingersoll Rand Co., Phillipsburg, N. J.

*Illustrated in pictorial center spread, Pages 62-63.

Office
*Mimeograph photochemical printer, A. B. Dick Co., Chicago.
*Ediphone, Thomas A. Edison Inc., West Orange, N. J.
Mechanical check writer, The Todd Co. Inc., Rochester, N. Y.

Packaging
Wrapper, Package Machinery Co., Springfield, Mass.
Bag making machine, Peters Machinery Co., Chicago.
Weighing unit, Weigh Right Automatic Scale Co., Joliet, Ill.

Pressing
Trouser shaper, Huebsch Mfg. Co., Milwaukee.
Sleeve finisher, W. M. Cissell Mfg. Co., Louisville, Ky.

Printing
Aniline press, Kidder Press Co., Dover, N. H.
Blower, Breuer Electric Mfg. Co., Chicago .
Automatic metal feeder, Intertype Corp., Brooklyn.
Lift and pile feed, Charles Wagner Litho Machinery Co., Hoboken, N. J.

Rubber
Four-press rubber molding machine, French Oil Machinery Co., Piqua, O.
Rubber mills, Stewart-Bolling & Co., Cleveland.
Dispersion machine, Promulsor Corp., New York.
Extractor, Tolhurst Centrifugal Div., American Machine & Metals Inc.

Restaurant
*Ice cream freezer, Tuthill Pump Co., Chicago.
Odor absorber, W. B. Connor Engineering Corp., New York.
Glass washer, Hamilton-Beach Co., Racine, Wis.
Ventilator, J. L. Skuttle Co., Detroit.
Electric fryer, Wells Mfg. Co., San Francisco.
Sterile ray cabinet, Liquid Carbonic Corp.

Textile
Prebroaching machine, Proctor & Schwartz Inc., Philadelphia.
Doubling and twisting machines, The Atwood Machine Co., Stonington, Conn.
Stocking heeler, Robert Reiner Inc., Weehawken, N. J.
Precision knitter, W. C. Lipe Inc., Syracuse, N. Y.
Mercerizing padder, Textile Finishing Machinery Co., Providence, R. I.

All About Arc Welding
THE NEW HANDBOOK
Your Guide to Progress

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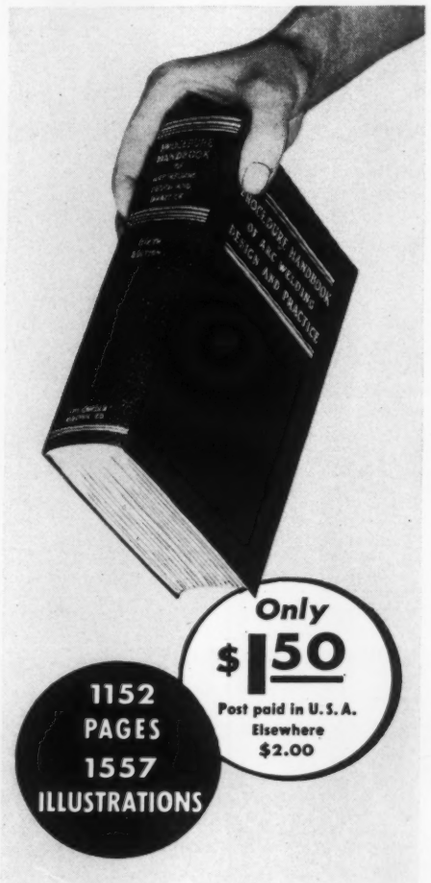

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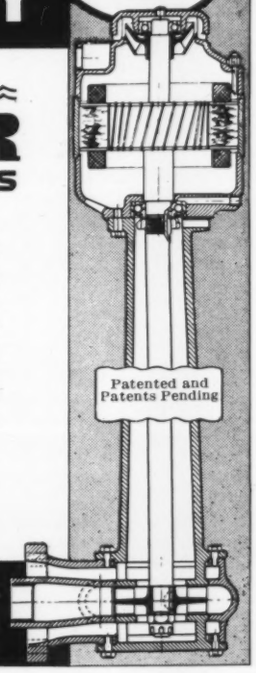

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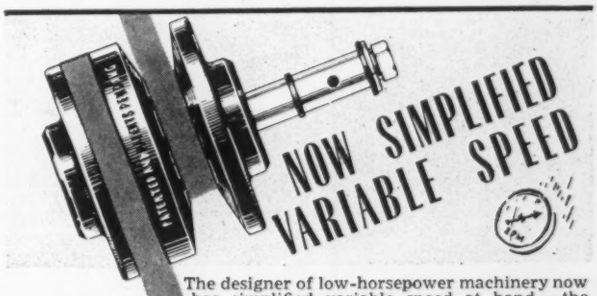

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